Attenuation Correction in Brain Positron Emission Tomography Studies

Domingos Vieira[1], Ricardo Vardasca[2] , João Manuel R. S. Tavares[1]

[1] Instituto de Ciência e Inovação em Engenharia Mecânica e Engenharia Industrial (INEGI), Faculdade de Engenharia, Universidade do Porto, Portugal
[2]LABIOMEP, UISPA-LAETA-INEGI, Faculdade de Engenharia, Universidade do Porto, Portugal
mim09007@med.up.pt

INTRODUCTION

Molecular neuroimaging using physiologic techniques such positron emission tomography (PET) has evolved into an important scientific field and is progressively gaining importance in the clinical point of view. Significant progress has been made in the design of high-resolution PET detectors dedicated to brain research, and in the development of quantitative imaging tools integrating accurate image correction techniques and sophisticated image reconstruction algorithms. However, especially with the advent of multimodality imaging equipment, linking Computerized Tomography to PET (PET-CT) or the ability of Magnetic Resonance Imaging (PET-MRI), emerging clinical and research applications of molecular brain imaging demand even greater levels of accuracy and precision and, therefore, impose more challenges in quantitative capability of PET. Since the beginning of PET techniques application in medical arena, photon attenuation in tissues is considered the most important physical factor degrading PET image quality and quantitative accuracy. Quantitative PET image reconstruction requires an accurate attenuation correction (AC) map of the object under study for attenuation compensation.
The aim of this review was to describe, compile and review the existing scientific and technical contents in the literature about methods that have been devised to correct for photon attenuation in brain PET studies.

EXPERIMENTAL METHODS

A literature review was performed, following a PICO methodology with the question: "What is the main approaches for AC in brain PET studies?".
Based on the formulated question, key words and key phrases were identified for scientific database research: "Brain", "PET" and "attenuation". The PubMed of US National Library of Medicine National Institutes of Health platform was used as digital repository of research. With the set of publications obtained, their feasibility was verified based on the application of the following exclusion criteria: possibility of access to the full version of the publications; verification of redundant items; empirical analysis of abstracts based on their relevance to the research question (publications concerning other technical issues than the PET attenuation brain region were rejected).

RESULTS

252 publications in the database were obtained and classified in different methods for determination of the AC map in neurological PET studies: approaches that do not require transmission scan (calculated methods, atlas-guided methods and other sophisticated methods) and measured transmission-based approaches (radionuclided-based transmission scanning, X-ray-based transmission scanning, solutions requiring segmented MRI).

DISCUSSION AND CONCLUSION

Several methods have been proposed to correct photon attenuation in brain PET studies. Significant attention has been devoted to optimizing computational performance and to balancing conflicting requirements. Approximate methods and tools suitable for clinical routine applications constitute the greater emphasis on scientific research in Nuclear Medicine field in achieving accurate quantitative measurements. The number of scientific contributions related to this subject has been gradually increasing, showing the dynamically changing field of attenuation correction in brain PET. With the results obtained, it was possible to present the physical and methodological basis of photon attenuation and

summarizes state of the art developments in algorithms used to derive the attenuation map aiming at accurate AC of brain PET data. Future research must be developed in this field, in particular, for an effective application of AC to recent multimodality imaging challenges.

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