Postprocessing and Cross Validation

Modeling and Quantification

Quantitative Assessment of Regional Myocardial Perfusion using PET

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Learning Objectives:

1. To learn basic principles and assumptions when assessing regional myocardial blood flow by means of a compartmental modelling approaches.
2. To learn practical procedures to assess quantitative regional myocardial blood flow using PET and typical radio tracers such as 15O-water, 13N-ammonia and others.
3. To learn limitations and possible error factors in the estimated myocardial flow values.

Regional myocardial blood flow is defined as a perfusion rate over a unit time per unit mass of the myocardial tissue, and can often be a critical factor in various pathophysiological conditions. Perfusion supplies oxygen, substrates and regulatory agents to the tissues and washes out unnecessary compounds and waste. In addition to the situation with overt lack of perfusion leading to ischemia (e.g. due to vascular disease), perfusion has been found to be abnormal in many inflammatory and metabolic disorders. A number of efforts have been made to quantitatively, and non-invasively assess the tissue perfusion in vivo, in both preclinical and clinical experiments. Of those, PET provides unique characteristics, allowing 3-dimensional dynamic acquisition with very high sensitivity and accuracy. The methodology is based on kinetic modeling of the tracer behavior in the body, for several short-lived tracers such as 82Rb, 13NH3, H215O etc. This talk provides an overview of theory and application of the technique that quantitatively assess regional myocardial blood flow using PET in clinical and preclinical settings. Following issues will be discussed:

1. Basic principles for quantitative assessment of regional myocardial blood flow from PET images.Compartmental model approachesWhat to assume, and how to model?
2. Characteristics and kinetic modeling for typical radio-labeled tracers: 82Rb, 13NH3, H215O for PET, and 99mTc-ligands and 201Tl for SPECT, etc.
3. Intrinsic limitations and error factors which need to be taken into account. Partial volume effectFirst-pass extraction fraction of the radio tracerRetention of the tracer in the myocardial tissueMetabolite production in the arterial bloodEstimation of the arterial input function from PET images
4. Practical procedures, including the radiotracer production, PET scanning protocols, data analysis, etc.
5. The procedures to generate quantitative images in PET, particularly when acquired in 3D mode. What corrections are needed, and how accurate are they?
6. Example applications of quantitative assessment in ischemic cardiac diseases etc.
7. Application of the technique to other organ tissue flow assessment

Relevant Publications:

1. Koshino K, Watabe H, Enmi J, Hirano Y, Zeniya T, Hasegawa S, Hayashi T, Miyagawa S, Sawa Y, Hatazawa J, Iida H. Effects of patient movement on measurements of myocardial blood flow and viability in resting 15O-water PET studies. J Nucl Cardiol. 19(3);524-533,2012
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4. Teramoto N, Koshino K, Yokoyama I, Miyagawa S, Zeniya T, Hirano Y, Fukuda H, Enmi J, Sawa Y, Knuuti J, Iida H. Experimental Pig Model of Old Myocardial Infarction with Long Survival Leading to Chronic Left Ventricular Dysfunction and Remodeling as Evaluated by PET. J Nucl Med. 52(5);761-768,2011
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