INTRODUCTION

The kidney performs three essential functions: the excretory, the regulatory and the endocrine functions; this contributes to the complexity of anatomy and physiology of the human renal system. Non-invasive radionuclide procedures in the evaluation of renal diseases have been accepted increasingly as effective and valuable alternatives to older clinical methods: in fact "in vivo" nuclear medicine allows assessment of the three renal processes involved in the elaboration of urine: glomerular filtration, tubular reabsorption and tubular secretion.

Kidney agents and specific procedures allow measurement of a) glomerular filtration rate, GFR, b) total renal blood flow, c) total effective renal plasma flow, d) effective renal plasma flow, ERPF, e) morphology of the kidneys, f) residual urine volume, g) uterovesical reflux and h) integrity of the urinary collecting system.

GFR, ERPF and morphology are tests frequently and routinely performed in any nuclear medicine departments and therefore they are object of more detailed considerations.

Glomerular filtration rate: GFR. For glomerular filtration the hydrostatic pressure at glomerular capillary level yields a net positive pression to overcome frictional resistance in the membrane resulting in a protein free filtrate plasma.

Glomerular filtration may be quantitated by measurement of the renal clearance rate of a particular substance in plasma provided that this substance meets established criteria. The reference non-isotopic method for the assessment of GFR is the "inulin clearance" even if other substances, like hypsulfite or mannitol or creatinine, have been used in the past.
The criteria for radiopharmaceutical acceptance in GFR measurement foresee a substance:
- not bound to serum proteins
- freely filterable by glomeruli
- inert and not metabolized
- neither reabsorbed nor secreted by tubules
- non-toxic and non-influencing renal function over a wide range of concentrations
- comparing favourably with the reference method, i.e. inulin clearance.

The radioisotopic methods may be based on blood clearance determination by plasma blood sampling or by the use of regions of interest (ROI) for renogram deconvalutions.

Effective renal plasma flow: ERPF. The tubular secretory process involves the transport of materials from the pertubular fluid (after tubular reabsorption) to the tubular lumen. The active sites of secretion are the proximal tubules and a continuous energy supply is necessary. The clearance of a tubular substance would give a measure of the renal plasma flow.

If the compound were totally extracted in a single pass by the kidney, the clearance would give the total renal plasma flow; more realistically, the calculated clearance would be somewhat less than the total plasma flow; i.e. the effective renal plasma flow. The clearance of the p-amino hippuric acid, PAH, should be considered as the reference non-isotopic method for measuring the effective renal plasma flow or ERPF.

In fact approx. 90% of the administered PAH is extracted during one passage through the normal kidney. In order to replace the PAH clearance method, radiopharmaceuticals should be:
- non bound to serum proteins
- rapidly excreted by tubules
- not extensively metabolized
- not reabsorbed
- non-toxic and not-influencing renal functions over a wide range of concentrations