Glomerular filtration rate

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During **glomerular filtration (GF)**, ultrafiltration of blood plasma happens. The glomerular filtrate therefore has similar chemical and physical properties to blood plasma, however: the filtrate is almost protein-free.

Glomerular filtration is best determined by substances that are excreted only by glomerular filtration and are not reabsorbed. An example is the fructose polymer *inulin*:

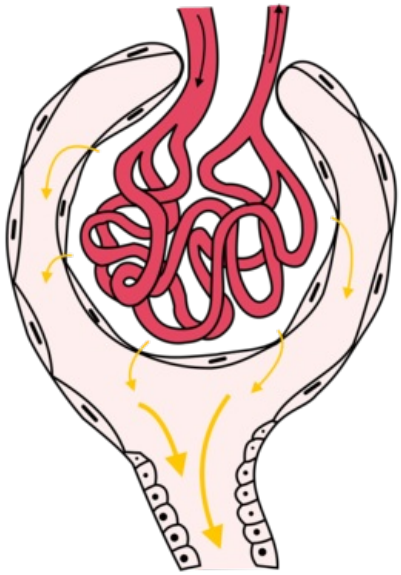
$$GF \cdot P_{in} = U_{in} \cdot V$$

or

$$GF = \frac{U_{in} \cdot V}{P_{in}},$$

where

P_{in} = plasma concentration of the substance,
GF = glomerular ultrafiltrate volume,
U_{in} = urine concentration of the substance, and
V = urine volume.



Glomerulus - filtration occurs here

The term $\frac{U_{in} \cdot V}{P_{in}}$ is also referred to as **clearance** and determines the ability of the kidney to excrete each substance.

The size of the GF is affected by:

- hydrostatic pressure in Bowman's capsule;
- the amount of renal blood flow;
- possible damage to the permeability of the filtration membrane;
- plasma proteins and their concentration;
- the size of the filtering area of the glomerular capillaries, which may be reduced by contraction of the mesangial cells and their processes due to angiotensin II;
- pregnancy - in the first trimester it can increase by up to 50%.

During one minute, about 1200 ml of blood flows through the kidneys, which represents 660 ml of plasma. 128 ml of plasma per minute and 180 l per 24 hours are transferred to the glomerular filtrate. This amount of ultrafiltrate is converted by the kidneys into 1-1.5 l of definitive urine - the rest is returned to the circulation.

The volume fraction of plasma that is filtered from the glomerular capillaries into the Bowman's capsule is called the **filtration fraction**. In a healthy individual, the filtration fraction accounts for about 20 % of renal plasma flow. An increase in the filtration fraction may be an indicator of chronic polycythemia. Although the renal blood flow is reduced in polycythemia, the volume of glomerular ultrafiltrate is not less because the filtration fraction is increased (due to the adaptive function of the glomeruli).

The capillaries of the glomerulus maintain a high hydrostatic blood pressure and this is due to the resistance formed by the efferent arteriole (a difference from ultrafiltration in the tissue microcirculation).

Endogenous creatinine, which is produced by muscle metabolism, is most commonly used to determine glomerular filtration rate. However, if the plasma creatinine concentration is elevated, the test becomes less accurate because tubular secretion is enhanced and glomerular filtration rate is then overestimated (7 to 10%).

Examination:

The patient collects urine for 24 hours. During this time, he should follow a diet without excess protein. At the end of urine collection, a fasting blood sample is taken to determine the plasma creatinine concentration. Possible mistakes in measurement are either on the part of the patient who did not collect all the urine or on the part of the

nurse who did not measure the urine volume accurately. Plasma creatinine concentration and urinary creatinine excretion depend on muscle size and thus body surface area. If the measured creatinuria is 50 % lower than the expected values, the urine collection can be considered false.

Glomerular filtration rate by age and sex:

Age	Sex	GF [ml/s/1,73m^2]
2−20 years	no difference	1,80 ± 0,40
20−40 years	men	2,17 ± 0,39
20−40 years	women	2,09 ± 0,28
40−60 years	men	1,85 ± 0,60
40−60 years	women	1,50 ± 0,50

Daily creatinine excretion values according to age and sex (μmol/kg/24 h)

Age	Men	Women
20−29	196 ± 37	170 ± 30
30−39	192 ± 70	174 ± 38
40−49	174 ± 40	152 ± 32
50−59	166 ± 40	131 ± 24
60−69	139 ± 20	116 ± 26
70−79	131 ± 24	100 ± 24

Glomerular filtration can also be determined with the **radionuclides EDTA and DTPA**. We inject these substances intravenously and then measure the decrease in their plasma activity over time. The advantage is that there is no need to collect urine over a long period of time, thus reducing the risk of possible errors in the examination.

Links

Related articles

- Examination of kidney function
- Glomerular Filtration

Used literature

- KITTNAR, Otomar, et al. *Lékařská fyziologie.* 1. edition. Praha : Grada, 2011. 790 pp. ISBN 978-80-247-3068-4.
- NEČAS, Emanuel, et al. *Patologická fyziologie orgánových systémů : Část II.* 1. edition. Praha : Karolinum, 2003. 380 pp. ISBN 80-246-0674-7.