

PHYSICAL BASIS OF BLOOD FLOW VELOCITY DETERMINATION (DOPPLER AND LASER FLOWMETRY)

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Abstract: *this in the article clinical in diagnostics wide applicable blood stream speed determination methods physicist basics, especially Doppler ultrasound and laser flowmetry mechanism, operation principles, technical features and medical in practice application illuminated. Doppler effect, acoustic waves diffusion, laser radiation biological tissues with mutual impact such as physicist to processes scientific based comments Also, in the article two of technology diagnostic accuracy, measurement boundaries, advantage and restrictions according to analytical tables The study is based on Doppler and laser flowmetry methods clinical advantages compare, their work efficiency assessment and in the field modern technologies application opportunities to show focused.*

Keywords: *doppler effect, blood flow, laser flowmetry, ultrasound diagnostics, hemodynamics, light scattering physics, acoustics waves, Doppler sonogram, perfusion, photon spread.*

Blood rotation organism main vital functions in providing central place Blood stream speed and his/her dynamic changes heart and blood vein system activity, peripheral of the veins functional status and tissues perfusion level in evaluation diagnostic importance has. Therefore clinical in medicine blood flow of determination high to sensitivity has, invasive not happened and safe measurement methods wide is applied.

This in the direction two technology — Doppler ultrasound diagnostics and laser flowmetry (laser Doppler flowmetry, LDF) separately importance profession Both are subject to the Doppler effect. based although, one acoustic waves, the second from electromagnetic (light) radiation uses.

This of technologies physicist basics, performance principle, device architecture, analysis algorithms and clinical application sectors deep scientific approach with seeing is released.

Doppler ultrasound physicist basics

Doppler effect essence





Doppler effect – wave source or acceptance the one who does movement as a result observable frequency Blood flow vein inside moving erythrocytes acoustic the waves reflection to represent through is measured.

Doppler ultrasound of devices work principle

Device following from modules consists of :

Ultrasound generator

Piezoelectric probe

Echo signal acceptance those who do

Filtering and reinforcement chains

Spectral analysis module

Laminar and turbulent blood flow echo signal spectral the composition Clinical in practice pulsed Doppler, continuum Doppler and color Doppler mapping is used.

Laser flowmetry physicist basics

Laser beams to knit entrance

Laser flowmetry red or infrared laser the rays to knit to direct based on . Erythrocytes laser the rays distributes and returned Doppler shift of rays occurs .

Light -scattering mechanism

the fabric photons:

absorbed ,

will be returned ,

elastic and inelastic spreads .

Inelastic spread exactly moving to erythrocytes related is the Doppler frequency appearance will be.

Laser flowmetry signals again work

Device returned laser intensity statistic to models based on evaluates :

microcirculation index

perfusion unit (PU)

microangiopathy indicators

LDF skin depth up to 1–2 mm perfusion determines , that is capillary blood flow about information gives .

Scientific tables and their wide analysis

Below is Doppler and laser flowmetry measurements main physicist indicators according to three table and they on in detail analysis is brought .

Doppler and laser flowmetry physicist parameters compare

Table 1.

Parameter	Doppler ultrasound	Laser flowmetry
Wave type	Acoustic	Optical (laser)



Wave length	0.1–0.5 mm	600–900 nm
Measurement depth	1–4 cm	0.5–2 mm
Frequency	2–10 MHz	10 ¹² –10 ¹⁴ Hz
Blood flow measurement	Artery , vein	Capillaries
Accuracy	High	Very high

Table 1 analysis

This from the table visible as it stands , Doppler ultrasound deep located artery and in the veins the flow to measure Designed for . Laser flowmetry and photons spread border because of superficial capillary on the networks perfusion measures . Frequencies between difference millions once equal is , Doppler ultrasound acoustic nature and laser flowmetry optical features clear separate stands .

Measurement accuracy and diagnostic efficiency

Table 2.

Indicator	Doppler ultrasound	Laser flowmetry
Speed accuracy	±5%	±2%
Laminar the flow determination	Very effective	Average
Turbulent the flow assessment	Limited	Not rated
Microcirculation	Low sensitivity	Very high sensitivity
Clinical application opportunity	Wide	Special in the fields

Table 2 analysis

Table 2 data this shows that Doppler ultrasound big in the veins laminar and turbulent streams clear registration can takes . But microcirculation at the level sensitivity slow will be . Laser flowmetry and capillary perfusion to changes very sensitive . So, both technology different to goals intended are, they are each other fills.

Clinical application directions Table 3.

Direction	Doppler ultrasound	Laser flowmetry
Heart and blood vein system	Yes	No
Neurology	Limited	Yes
Dermatology	Low	Very wide
Endocrinology	Average	High (diabetic) angiopathy)
Resuscitation	Yes	Limited

Table 3 analysis

To the table according to Doppler ultrasound heart and blood vein system diagnostics main is a tool. Its using stenosis, thrombosis, regurgitation, valvular pathologies Laser flowmetry and more microcirculation with related diseases in the assessment - diabetic angiopathy, burns, trophic wounds, capillaries spasms in determining to advantage has.

Results and Discussion





Research results this shows that blood flow of determination modern technologies different physicist to principles based are , they are clinical to tasks suitable accordingly is used .

Discussion to be done main aspects :

✓ Doppler ultrasound arteries and in the veins stream speed high in accuracy record Spectral Doppler blood whether the flow is laminar or turbulent shows. Colorful Doppler and stream direction describes.

✓ Laser flowmetry capillary level blood rotation sensitive in a way measures the kinetic energy of erythrocytes photons inelastic to spread take it comes, this and perfusion unitary in indicators reflection will reach.

✓ Both of the method physicist basics biological in tissues of the waves spread features with directly related. Acoustic waves deep enters , light and light spreads .

✓ Clinical in practice they each other competition doesn't, maybe each other fills.

Conclusion

In the article blood stream speed of determination two main technology — Doppler ultrasound and laser flowmetry physicist basics , measurement mechanism, technical parameters and clinical application analysis The research was conducted this shows that :

✓ Doppler ultrasound deep veins flow in determining the most effective method is considered .

✓ Laser flowmetry and capillary level microcirculation in monitoring grass to sensitivity has.

✓ Both technology to the Doppler effect based although, different wave types — acoustic and optical — uses.

✓ Tables based on take visited analysis, methods each other filler to the feature has that it is confirms.

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