QON- TOMIR TIZIMI UCHUN KVAZI-BIR O'LCHAMLI GEMODINAMIKA TENGLAMALARINING QO'LLANILISHI

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Annotation: *This article describes an overview of the mathematical model of the circulatory system for the cardiovascular system and provides a basis for the mathematical representation of aggregate medical parameters, such as the, objects and research methods, goals, and objectives of the thesis, blood volume, scientific novelty, practical significance, self-regulation and influence on the upper and inner parts of the heart.*

Key words: *Equations of hemodynamics in the quasi-one-dimensional approximation, science, common vascular zone, self-regulation, effect on the upper and working heart, medical parameters.*

Аннотация: *В данной статье представлен обзор математической модели системы кровообращения для сердечно-сосудистой системы и дана основа для математического представления совокупных медицинских параметров, таких как, объекты и методы исследования, цели и задачи диссертации, объем крови, научная новизна, практическая значимость, саморегуляция и влияние на верхние и внутренние частьи сердца.*

Ключевые слова*: Уравнения гемодинамики в квазиодномернотприближении, наука, общая сосудистая зона, саморегуляция, воздействие на верхние отделы и работающее сердце, лечебные параметры.*

Annotatsiya: *Ushbu maqolada yurak-qon tomir tizimi uchun matematik modelining umumiy ko'rinishini hamda berilgan tebglama orqali ifodalanishini tavsiflaydi va tadqiqot usullari, maqsadlari va natijalari, qon hajmi, ilmiy yangiligi, amaliy ahamiyati, o'z-o'zini tartibga solish va yurakning yuqori va ichki qismlariga ta'siri haqida ask etgan.*

Kalit so'zlar: *Gemodinamikaning kvazi bir o'lchovli yaqinlashuvdagi tenglamalari, umumiy tomir zonasi, o'z-o'zini tartibga solish tizimi, yurakning yuqori va past qismiga ta'siri, tibbiy ko'rsatkichlar.*

KIRISH

Kvazi-bir o'lchovli yaqinlashuvchi gemodinamikaning tenglamalari bir algebraik munosabat bilan yopiq tizim uchun qisman hosilalarda mavjud bo'lgan ikkita differentsial tenglamalar tizimini ifodalaydi.

Uzluksizlik va harakat tenglamalari: Massaning saqlanish qonunini ifodalovchi differentsial tenglama (uzluksizlik tenglamasi) quyidagicha ko'rinishga ega:

$$\frac{dS}{dt}+\frac{duS}{dt}=0$$

Impulsning o'zgarish qonuni differentsial tenglamaga olib kelishi quyidagi tenglama orqali ifodalanadi/

$$\rho\frac{duS}{dt}+\rho\frac{du^2\ S}{dx}+\frac{dpS}{dx}-p\frac{duS}{dx}=q_f\,S,$$

hamda ushbu shaklga aylantiriladi

$$\frac{dy}{dt}+u\frac{dy}{dx}+\frac{1}{\rho}\frac{dp}{dx}=\frac{q_f}{\rho}$$

Bu erda f $_q$ - tashqi kuchlarning massa zichligi. Bir o'zgaruvchi t - vaqt.

X fazoviy o'zgaruvchisi sifatida yoy uzunligi tomirning aylana kesmalarining markazlaridan o'tadi. S(x, t) – koordinata x va t vaqtga bog'liq bo'lgan koordinataning maydon ko'ndalang kesimiga ega.

Qon harakatining tezligi tomirning o'qi bo'ylab yo'naltirilgan hisoblanadi dev ifodalaymiz, tomirning butun doira qismi uchun bir xil bo'ladi va (x, t) ni bildiradi. Suyuqlik (qon) ichidagi bosim p(x,t) bilan belgilanadi. Qon zichligi $S=S(p)$ko'rsatkichlari doimiy t (siqilmaydigan suyuqlik). Holat tenglamasi: (1.1.1) va (1.1.2) tenglamalarni yopish uchun qo'shimcha munosabatdan foydalanamiz.

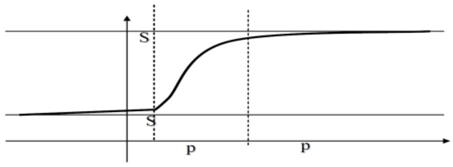
$$S=S(p)$$

Tenglama (1.1.3) eksperimental ravishda tomirning fazaviy maydoni va koordinata ichidagi bosim o'rtasidagi bog'liqlikni ko'rib chiqish mumkin. Gemodinamik masalalarda *S = S(p)* tenglama gaz dinamikasidagi baratropik gazning holat tenglamasi kabi rol o'ynaydi va analogiya bo'yicha bundan buyon biz uni shunday deb ataymiz.

Ushbu maqolada biz o'zimizni tenglamalar tizimini yopiq tizim bilan cheklaymiz, bu tomirning fazaviy maydoni bo'yicha tomir ichidagi qon bosimiga bog'liqligi va biz uning elastik-mexanik xususiyatlarini hisobga olamiz. Kichik va yuqori bosim qiymatlarida erishilganda uning fazaoviy maydonining chegara qiymatlariga muvofiq koordinatalari orqali aniqlanadi. Qon tomir inson kabi murakkab tizimlarining arterial qismidagi asosiy tomirlarining xarakteristikasi, bog'liqlik turi (1.1.3) 1.1.1- rasmda ko'rsatilgan .

METODLAR

Kesmaning bosimga bog'liqligining muhim xarakterli xususiyati - bu bosimning oshishi bilan kesmaning ortishi, ya'ni ishlash shartlaridab biridir.



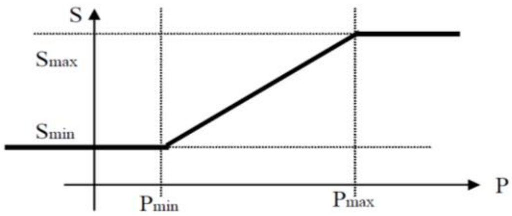
1.1.2-rasm. Holatning model tenglamasining eng oddiy shakli

Holatning model tenglamasining eng oddiy shakli keltirilgan1.1.2-rasm va quyidagi formula bilan aniqlanadi

$$S(p) = \begin{cases} S_{min} + \dfrac{S_{max} + S_{min}}{p_{max} - p_{min}}(p - p_{min}), \\ S_{min} \\ S_{\ max} \end{cases}$$

$$p_{\min} \quad < p < p_{max}$$
$$p < p_{min}$$
$$p_{\max} \quad \geq p$$

Bu erda min, max S, S, p, p - ma'lum bir o'lchamli koordinata xarakteristikalari.



1.1.2-rasm. Umumiy holat tenglamalari

Quyida biz umumiy holat tenglamalaridan foydalanamiz .

(1.1.1), (1.1.2) va (1.1.3) tenglamalar birgalikda gemodinamikaning kvazi bir o'lchovli yaqinlashuvdagi tenglamalari tizimidir.

Gemodinamik tenglamalarning xossalari. Olingan tenglamalar

Gemodinamikadan (1.1.1), (1.1.2) va (1.1.3) bir qator xarakterli xususiyatlarga ega. At, xususan, tenglamalar turi va ularni ifodalashning turli shakllari qiziqish uyg'otadi.

Gemodinamikaning giperbolik tipdagi tenglamalari.

Quyida hamma joyda biz buni taxmin qilamiz

$$S'_p \quad = \frac{dS(p)}{dx} \quad > 0$$

$$c^2 = \frac{S(p)}{\rho S'_p(p)}$$

Keling, $\vec{Y} = (p, u)^T, \vec{F} = (0, q_f/p/)^T$va matritsa$A = \begin{pmatrix} u & pc^2 \\ \frac{1}{p} & u \end{pmatrix}$ vektorni kiritamiz.

(1.1.1), (1.1.2) tenglamalarini quyidagicha yozish mumkin

$$\frac{d\,\vec{Y}}{dt} + A\frac{d\vec{Y}}{dx} = \vec{F}$$

Xarakteristik tenglamani yechish uchun $\det(A - \lambda E) = 0$ga teng bo'lgan A matritsaning xos qiymatlarini topib qo'yamiz

$\lambda^+ = u + c$ va $\lambda^- = u - c$

Hamda (1.1.4) shartga ko'ra, bu raqamlar haqiqiy va boshqacha.

Binobarin, (1.1.5) tenglamalar tizimi giperbolik tipdagi sistemadir.

E'tibor bering, qiymat mazmunli ma'noga ega

$$c = \sqrt{\frac{S(p)}{\rho S'_p(p)}}$$

gaz dinamikasidagi tovush tezligiga o'xshash ekanligini bilamiz. Shunisi ahamiyatligi uchun xarakterli xususiyatga ega tovush tezligining suyuqlik oqimi tezligidan ustunligidadir, ya'ni $|u|/c \ll 1$.

Gemodinamik tenglamalarda Riman parametrlari va tenglamalarni yozish xarakteristikasi bo'yicha aniqlanishini hisozbga olamiz. Gemodinamik tenglamalar uchun xarakterli munosabatlar quyidagi shaklga ega:

$$\pm\frac{1}{\rho c(p)}\frac{dp}{dt}+\frac{du}{dt}+\lambda\pm\left(\pm\frac{1}{\rho c(p)}\frac{dp}{dt}+\frac{du}{dt}\right)=\frac{q_f}{\rho}$$

$\varphi(p)=\int_a^p\frac{d\xi}{\rho(c)\xi}$ funktsiyadan foydalanib shu shaldagi tenglama hosil bo'ladi.

qayerda a - ixtiyoriy son, biz oxirgi tenglamalarni shu shaklda yozishimiz mumkin:

$$\frac{d}{dt}(\pm\varphi+u)+\lambda^{\pm}\ \frac{d}{dx}(\pm\varphi+u)=\frac{q_f}{\rho}$$

Biz ikkita yangi funktsiyani kiritamiz (Riemann parametrlari) va undan keying qadamda paydo bo'ladigan tenglama hosil bo'ladi:

$$R^{\pm}(u,p)=u\pm\varphi(p)$$

Natijada (1.1.6) tenglamalar ikkita uzatish tenglamasiga qisqartiriladi $^{+}$ va R $^{-}$ parametrlari :

$$\frac{dR^{\pm}}{dt}+\lambda^{\pm}\ \frac{dR^{\pm}}{dx}=\frac{q_f}{\rho}$$

(1.1.7) tenglamalar Riman parametrlari uchun yozilgan gemodinamik tenglamalardir.

KUTILADIGAN NATIJALAR

(1.1.7) tenglamalari orqali berilgan mustaqil o'zgaruvchilar (x, t) tekisligidagi xarakteristikalar turkumidagi ikkita tipini ko'rib chiqamiz.

$$\frac{dx^{+}\ (t)}{dt}=\lambda^{+},\frac{dx^{-}\ (t)}{dt}=\lambda^{-}$$

(1.1.7) funktsiyalar uchun tenglamalaridan $R^{\pm}t, x^{\pm}(t))$ mos ravishda va xarakteristikalar mavjud X^{+} sifatida ifodalanishi mumkin va X^{-}:

$$\frac{dR^{-}}{dt}=\frac{q_f}{\rho}$$

$$\frac{dR^{-}}{dt}=\frac{q_f}{\rho}$$

quyidagi ko'rinishga ega bo'ladi.

Xususan (1.1.8) tenglamdan shunday natija kelib chiqadiki, agar tashqi kuchlar bo'lmasa, u holda bo'ladi $q_f(x,t)=0$, u holda Riman parametrlari R $^{+}$ va R - mos ravishda X^{+} *va* X xarakteristikalari bo'yicha doimiy qiymatga ega bo'ladi hamda (p) φ funktsiyalari ifodalarini va ularni o'zgartirilgandan so'ng $R^{\pm}(u,p)S$ =*S(p)* tenglama bog'liqligini hisobga olgan holda, $q_f(x,t)=0$ teng deb hisoblaymiz, biz uning shunday xarakteristikalarga ekanligini oldin bilamiz va natija ham shunga yaqin.

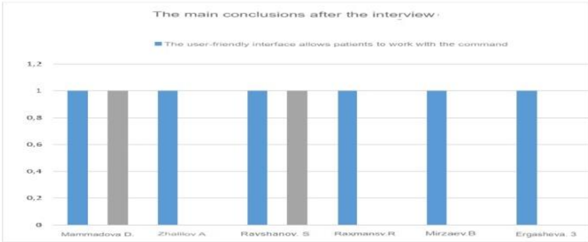
X^{+} *va* X mos ravishda quyidagi xarakteristikaga ega bo'lgan

$$du \pm 2\frac{d(\sqrt{s})}{\sqrt{\rho S'_p}} = \frac{q_f}{\rho}dt$$

munosabatlar differensiallari uchun yozilgan tenglamaga ega.

XULOSA

Ushbu grafikda shifokorlarning yuqoridagi berilgan matematik model asosida desktop uchunyozilgan dasturidan qanday foydalanishlari haqi



1.3-rasm. Suhbatdan keyingi asosiy xulosalar dagi natijalari ko'rsatilgan. Dasturni yaratishda do’stona interfeysdan foydalanib tavsiflangan yondashuvli muammoni mustaqil bloklarga bo'lish imkonini beradi.

Har bir koordinatadagi kabi hamda tenglamalar orqali hisoblashda va ularning o'rnatilishining har bir nuqtasida oqimni hisoblash imkoni beradi. Modelning soddaligi uni murakkabligi va shu bilan ko'plab omillarning ta'sirini hisobga olgan holda aks ettirish imkonini beradi.

		Task1.Treatment methods in this section should be derived from conventional tests			Task 2. If the patient's usual tests are out + then do not send for a deep examination , if on the contrary, the patient will be sent for a deep examination			Task 3. In-depth survey consists of calculated data based on mat. models that will help you detect the disease at what stage			Task 4. Collecting cardiac data To process data for S, U, p, T, x, ro, L, T, K and BZ, displaying data as a chart		
2		Success	Time	Success	Success	Time	Success	Success	Time	Success	Success	Time	Success
3	P1	1	30	1	1	160	1	0	35	1	0	70	1
4	P2	1	45	1	0	90	0	0	50	0	1	100	0
5	P3	1	45	0	1	90	1	1	50	1	1	100	1
6	P4	1	50	1	0	100	0	0	55	1	0	100	0
7	Average	1,0	42,5	0,8	0,5	110,0	0,5	0,3	47,5	0,8	0,5	92,5	0,5
8	Number of reps	4	4	4	4	4	4	4	4	4	4	4	4

1.4-rasm. Matematik modellashtirish metrikasi

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