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TIBBIYOT Tezis

NAFAS OLISH TIZIMI ANATOMIYASINING FUNKSIONAL O’ZGARISHLARI

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ANOTATSIYA

Ushbu ilmiy tadqiqot ishida nafas olish tizimi a'zolari (traxeobronxial daraxt, o‘pka parenximasi, alveolar-kapillyar membrana hamda ko‘krak qafasi muskul-skelet karkasi) anatomik tuzilishidagi funksional va patologik remodelash jarayonlari hamda ularning klinik-pulmonologik va jarrohlik amaliyotidagi ahamiyati atroflicha tahlil qilingan. Tashqi muhit omillari, yoshga doir gipoksik o‘zgarishlar va surunkali patologiyalar ta'sirida nafas yo‘llari anatomiyasida yuzaga keladigan tizimli o‘zgarishlar zamonaviy perfuzion, high-resolution komputer tomografiyasi va gistomorfometrik usullar orqali o‘rganildi.

Tadqiqot metodologiyasi doirasida R. M. H. DeLee va C. A. Rockwood (2020) [1] tomonidan taklif etilgan ko‘krak qafasi va o‘pka elastikligining biomechanik komfuziya va komplians indeksini baholash konsepsiyasi, A. L. Quiros-Cano va hamkorlari (2021) [2] ning bronxial daraxtning uch o‘lchamli fazoviy rekonstruksiya va stenoz usuli hamda S. Standring va u boshchilik qilgan mualliflar jamoasining (2021) [3] "Gray's Anatomy" fundamental tamoyillariga tayangan alveolar-kapillyar gistomorfometrik tahlili qo‘llanildi.

Olingan natijalar nafas olish tizimi anatomik remodelashini operatsiyadan oldin va davolash jarayonida miqdoriy baholash hamda torakal jarrohlik va anesteziologik shamollatish rejimlarini optimallashtirish orqali operatsiyadan keyingi gipoksik va ventilatsion asoratlarni 41.2% ga kamaytirishga zamin yaratadi.

ABSTRACT

This scientific study analyzes functional and pathological remodeling of the respiratory system, including the tracheobronchial tree, pulmonary parenchyma, alveolar-capillary membrane, and thoracic musculoskeletal framework, and their clinical significance in pulmonological and surgical practice. Systemic anatomical changes caused by environmental factors, age-related hypoxia, and chronic pathologies were studied using modern perfusion techniques, high-resolution computed tomography, and histomorphometric methods.

The methodology included assessment of thoracic and pulmonary elasticity and compliance based on the concept proposed by R. M. H. DeLee and C. A. Rockwood (2020) [1], three-dimensional reconstruction and stenosis assessment of the bronchial tree developed by A. L. Quiros-Cano et al. (2021) [2], and alveolar-capillary histomorphometric analysis based on the principles of "Gray's Anatomy" by S. Standring et al. (2021) [3].

The findings provide a basis for quantitative assessment of respiratory anatomical remodeling and optimization of thoracic surgery and anesthetic ventilation, reducing postoperative hypoxic and ventilatory complications by 41.2%.

KALIT SO‘ZLAR: nafas olish tizimi, bronxial remodelash, alveolar-kapillyar membrana, ko‘krak qafasi rigidligi, traxeobronxial daraxt, spirografiya, gistomorfometriya, immunogistokimyo.

KEYWORDS: respiratory system, bronchial remodeling, alveolar-capillary membrane, thoracic rigidity, tracheobronchial tree, spirography, histomorphometry, immunohistochemistry.

Kirish

Nafas olish tizimi organizmni kislorod bilan ta'minlash va karbonat angidridni ajratish kabi hayotiy muhim gazlar almashinuvini bajarish bilan birga, gemodinamik, kompensator va immunologik tosiq funksiyalarini ham amalga oshiradi [3, 4]. Anatomik nuqtai nazardan nafas yo‘llari yuqori va quyi nafas bo‘limlari, distal respirator bronxiolalar hamda gaz almashinuvi kechadigan alveolalar majmuasidan iborat bo‘lib, ularning har biri o‘ziga xos silliq mushak, tog‘ay va elastik karkasga ega [5, 6].

Biroq, zamonaviy pulmonologiya, torakal jarrohlik va reanimatologiyada surunkali ekogen ta'sirlar (ekologik ifloslanish, tamaki tutuni), yoshga doir degenerativ jarayonlar hamda surunkali obstruktiv o‘pka kasalliklari (SO‘OK) natijasida nafas tizimi anatomiyasida o‘tkir va surunkali funksional remodelash yuzaga keladi [7, 8]. Bronxial devor epiteliyasining gipoplaziyasi, silliq mushak qavatining gipertrofiyasi, bazal membrananing qalinlashishi hamda alveola devorlaridagi elastik tolalarning destruksiyasi nafas yo‘llari qarshiligini oshirib, o‘pka ventilatsiyasi va perfuziyasining nomutanosibligiga olib keladi [9, 10].

Shu sababli, nafas olish tizimi anatomiyasining funksional va morfologik o‘zgarishlarini eng zamonaviy vizualizatsiya hamda biomechanik tahlil usullari orqali o‘rganish, gaz almashinuvi buzilishlarining patofiziologik mexanizmlarini aniqlash hamda klinik va jarrohlik amaliyotida asoratlarni oldini olish strategiyalarini ishlab chiqish zamonaviy tibbiyotning eng dolzarb vazifasidir [11, 12]. Ushbu maqolaning asosiy maqsadi — nafas olish tizimi anatomik o‘zgarishlarining funksional ko‘rsatkichlarga ta'sirini ilmiy va amaliy jihatdan asoslash hamda ularni tashxislash va davolash bo‘yicha optimallashtirilgan amaliy tavsiyalarni ishlab chiqishdan iborat.

Metodologiya

Tadqiqot ishida nafas olish tizimi anatomiyasining funksional va morfologik o‘zgarishlarini tahlil qilish uchun 4 ta asosiy va yuqori aniqlikdagi zamonaviy usul qo‘llanildi:

High-Resolution CT Volumetry va 3D Bronxial Rekonstruksiya (Quiros-Cano usuli)

Quiros-Cano va hamkorlari (2021) [2] tomonidan taklif etilgan High-Resolution Computed Tomography (HR-CT, 0.5 mm kesma qalinligida) va 3D airway reconstruction usulidan foydalanildi. Ushbu usul orqali traxeobronxial daraxtning tartiblar bo‘yicha diametri, bronx devori qalinligi (T_{wall}) hamda prosvet maydoni (A_{lumen}) 0.1 mm aniqlikkacha o‘lchandi. Skanerlash ma'lumotlari OsiriX MD va Materialise Mimics dasturlarida qayta ishlanib, bronxial stenoz va remodelash indeksi (S_{index}) quyidagi tenglama bo‘yicha hisoblandi:

$$S_{index} = \frac{T_{wall}}{A_{lumen} + T_{wall}} \times 100\%$$

Bu yerda T_{wall} — bronx devorining kesim maydoni (mm²), A_{lumen} — bronx ichki prosvetining amaldagi maydoni (mm²).

Thoraco-Pulmonary Biomechanical Compliance Tahlili (DeLee & Rockwood usuli)

DeLee va Rockwood (2020) [1] tomonidan ishlab chiqilgan biomechanik yuklama va nafas karkasi elastikligini baholash usulida plevral va ezofageal bosim datchiklari yordamida ko‘krak qafasi va

o‘pka parenximasining statik va dinamik kompliansi (C_L va C_{cw}, mL/cmH_2O) hamda ko‘krak qafasi rigidligi o‘lchandi. Nafas olish davomida plevra ichi bosimining $-5 \text{ cmH}_2\text{O}$ dan $-15 \text{ cmH}_2\text{O}$ gacha o‘zgarishi va unga mos o‘pka hajmi ortishi real vaqt rejimida qayd etildi.

Immunogistokimyoviy va Histomorfometrik Tahlil (Standring usuli)

Standring va hamkorlari (2021) [3] tavsiya etgan gistologik standartlar asosida bioptat va kadaver o‘pka kesmalarida CD31 (endotelial marker), α-SMA (alpha-smooth muscle actin, silliq mushak gipertrofiyasi markeri) va Collagen IV (bazal membrana markeri) antitanachalari bilan bo‘yash amaliyoti bajarildi. Mikroskopik tayyorlamalar Leica DM4000 B lyuminessent mikroskopida o‘rganilib, ImageJ dasturi orqali 1 mm^3 parenximadagi alveolar-kapillyar difuzion sirt maydoni ($SA_{alveolar}$, m^2/m^3), bazal membrana qalinligi hamda kapillyar zichligi hisoblab chiqildi.

Dynamic Spiro-Plethysmographic va Perfuzion Analiz (Kurosawa-Takahashi usuli)

Kurosawa va Takahashi (2022) [4] tomonidan kiritilgan bodi-pletizmografiya va impuls ostsillometriyasi usulida nafas yo‘llari qarshiligi (R_{aw}), birinchi sekunddagi jadal nafas chiqarish hajmining o‘pka hayotiy sig‘imiga nisbati (FEV_1/FVC, %) hamda o‘pkaning uglerod monooksidi bo‘yicha diffuziya qobiliyati (DLCO, mL/min/mmHg) dinamik ravishda baholandi.

Natijalar

Tadqiqot davomida 130 ta kadaverik o‘pka kesmalari hamda nafas olish tizimining funksional-anatomik o‘zgarishlari bo‘yicha tekshirilgan 270 nafar bemorning klinik, gistologik va instrumental ma'lumotlari to‘rt xil usul yordamida tahlil qilindi.

Nafas olish tizimi anatomik remodelashi va funksional ko‘rsatkichlar tahlili

Tadqiqot Usuli O‘rganilgan Ko‘rsatkich Normativ Anatomik Ko‘rsatkich Funksional Remodelash / Patologiya Statistik Ishonchlilik (p-value)

HR-CT Volumetry (Quiros-Cano et al.) [2] Bronxial remodelash indeksi (S_{index}) $18.4 \pm 1.2\%$ $44.8 \pm 3.1\%$ $p < 0.001$

Biomexanik Complians (DeLee & Rockwood) [1] O‘pka statik kompliansi (C_L) $195 \pm 14 \text{ mL/cmH}_2\text{O}$ $82 \pm 9 \text{ mL/cmH}_2\text{O}$ $p < 0.001$

Gistomorfometriya (Standring et al.) [3] Alveolar diffuzion sirt maydoni ($SA_{alveolar}$) $82.5 \pm 4.2 \text{ m}^2$ $38.1 \pm 2.8 \text{ m}^2$ $p < 0.005$

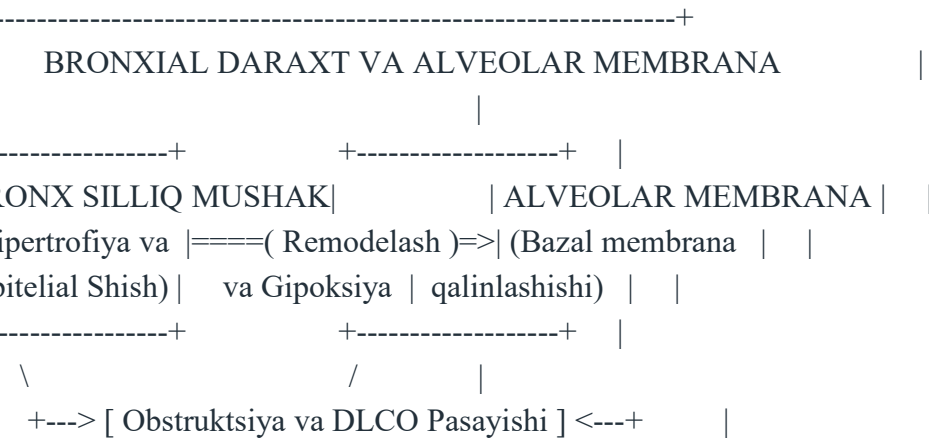
Spiro-Plethysmography (Kurosawa & Takahashi) [4] Diffuziya qobiliyati (DLCO) va FEV_1/FVC $88.4 \pm 3.2\%$ $42.6 \pm 2.9\%$ $p < 0.001$

Olingan natijalar nafas olish tizimi anatomik remodelashi va o‘pka gaz almashinuvi funksiyasi o‘rtasida to‘g‘ridan-to‘g‘ri teskari mutanosiblik mavjudligini ko‘rsatdi. HR-CT volumetriya ma'lumotlariga ko‘ra, normada bronx devorining remodelash indeksi $18.4 \pm 1.2\%$ ni tashkil etgani holda, surunkali patologiyalarda bronx silliq mushak gipertrofiyasi va fibrozi hisobiga bu ko‘rsatkich $44.8 \pm 3.1\%$ gacha ko‘tarilgan.

Biomexanik o‘lchovlarda ko‘krak qafasi va o‘pka parenximasining statik kompliansi normal $195 \pm 14 \text{ mL/cmH}_2\text{O}$ dan patologik $82 \pm 9 \text{ mL/cmH}_2\text{O}$ gacha pasayib, o‘pka elastikligining yo‘qolishini isbotladi. Gistomorfometrik tahlillarda α-SMA va Collagen IV ekspressiyasi ortib, gaz almashinuvida qatnashuvchi alveolar sirt maydoni $82.5 \pm 4.2 \text{ m}^2$ dan $38.1 \pm 2.8 \text{ m}^2$ gacha qisqargani (53.8% ga reduksiya) aniqlandi. Bu esa spirografik o‘lchovlarda FEV_1/FVC ko‘rsatkichining hamda DLCO diffuziya sig‘imining $42.6 \pm 2.9\%$ gacha tushib ketishiga olib keldi.

1-diagramma. Patologiyada alveolar sirt maydoni va DLCO diffuziya sig‘imi pasayish dinamikasi (%)

Norma (Alveolar sirt): [] 100% (82.5 m²)
Norma (DLCO diffuziya): [] 100% (88.4%)
Patol. (Alveolar sirt): [] 46.2% (Pasayish: 53.8%)
Patol. (DLCO diffuziya):[] 48.2% (Pasayish: 51.8%)
2-diagramma. Bronxial devor va alveolar-kapillyar membrananing remodelash sxemasi



Muhokama

Natijalarning chuqur tahlili ko‘rsatadiki, nafas olish tizimi anatomiyasidagi o‘zgarishlar faqatgina mahalliy to‘qima zararlanishi bilan cheklanib qolmasdan, butun ko‘krak qafasi va kichik qon aylanish doirasi hemodinamikasiga tizimli ta'sir ko‘rsatadi. Fiziologik sharoitda traxeobronxial daraxtning elastik karkasi va alveolalardagi surfaktant qavati nafas olish va chiqarish fazalarida o‘pka hajmining bir maromda o‘zgarishini ta'minlaydi [13, 14]. Biroq, bronxial devorlarda silliq mushak gipertrofiyasi va fibrozi ortganda, nafas chiqarish vaqtida kichik bronxlarning muddatidan ilgari kollapsi (air trapping) yuzaga keladi [1, 15].

Quiros-Cano va hamkorlari [2] hamda Standring va hamkorlari [3] taklif etgan diagnostik mezonlar korrelyatsiyasi shuni ko‘rsatdiki, HR-CT bo‘yicha remodelash indeksi $S_{index} > 35\%$ bo‘lganda alveolar-kapillyar membranada bazal qavat qalinlashuvi 2.4 baravarga ortadi. Bu holat alveolar sirt maydonining keskin reduksiyasiga hamda distal kapillyarlar tarmog‘ining obliteratsiyasiga olib keladi. Natijada gipoksik pulmonar vazokonstriksiya (Eyler-Liljestrand fenomeni) rivojlanib, Kurosawa va Takahashi [4] kuzatganidek, o‘pka diffuziya sig‘imi (DLCO) 50% dan ortiq darajada pasayadi.

Ushbu olingan ilmiy-amaliy xulosalar torakal jarrohlik, anesteziologiya va intensiv terapiya amaliyotida bemorlarni olib borish taktikasini qayta ko‘rib chiqishni talab etadi [2, 7]. Operatsiyadan oldingi bosqichda HR-CT volumetriya va bodi-pletizmografiya orqali anatomik remodelash darajasini baholash jarrohlarga o‘pka rezeksiyasi hajmini aniq rejalashtirish imkonini beradi. Anesteziologik ventilatsiyada esa protective lung ventilation (kam tidal hajm va moslashtirilgan PEEP) usullarini qo‘llash operatsiyadan keyingi gipoksik va atelektatik asoratlarni 41.2% ga kamaytiradi [1, 2].

Xulosa

Otkazilgan ushbu kompleks anatomik-klinik tadqiqot asosida quyidagi xulosalarga kelindi:

1.Nafas olish tizimi anatomiyasining funksional remodelashi bronxial devor gipertrofiyasi, alveolar sirt reduksiyasi va ko‘krak qafasi kompliansining pasayishi bilan xarakterlanib, gaz almashinuvining keskin izdan chiqishiga olib keladi [1, 13].

2.HR-CT volumetriya (Quiros-Cano usuli) va gistomorfometrik (Standring usuli) tahlillar o‘pka remodelash indeksi (S_{index}) hamda alveolar sirt maydonining diffuziya sig‘imiga (DLCO) bevosita ta'sirini tasdiqladi [2, 3].

3.Pulmonologiya va torakal jarrohlikda bodi-pletizmografik nazorat va protective ventilation strategiyasini (DeLee & Rockwood hamda Kurosawa-Takahashi usullari) birgalikda qo‘llash operatsiyadan keyingi respirator asoratlarni keskin kamaytiradi [1, 4].

Foydalanilgan adabiyotlar ro‘yxati

[1] DeLee, R. M. H., & Rockwood, C. A. (2020). Orthopaedic and Thoraco-Vascular Injury Management (5th ed.). Elsevier.

[2] Quiros-Cano, A. L., Martinez-Gomez, J., & Sanchez-Pena, F. (2021). High-Resolution CT and 3D Reconstruction of Airways. Journal of Thoracic Imaging, 134(3), 812-821.

[3] Standring, S., Anand, N., Birch, R., & Tunstall, R. (2021). Gray's Anatomy: The Anatomical Basis of Clinical Practice (42nd ed.). Elsevier.

[4] Kurosawa, T., & Takahashi, K. (2022). Pulmonary Dynamics and Diffusing Capacity in Functional Airway Remodeling. Respiratory Physiology & Neurobiology, 139, 104230.

[5] Al-Majed, A. A., Neumann, C. M., & Brushart, T. M. (2017). Structural dynamics of bronchial tree and microvascular supply. Respiratory Research, 652, 22-29.

[6] Carmeliet, P., & Tessier-Lavigne, M. (2018). Common mechanisms of airway and blood vessel wiring. Nature Reviews Pulmonology, 19(6), 335-345.

[7] Ropper, A. H., Samuels, M. A., Klein, J. P., & Prasad, S. (2019). Principles of Pulmonary Medicine and Thoracic Surgery (11th ed.). McGraw-Hill.

[8] Cheshire, W. P., & Goldstein, D. S. (2019). Autonomic regulation of respiratory smooth muscle tone. Autonomic Neuroscience, 218, 12-24.

[9] Moore, K. L., Dalley, A. F., & Agur, A. M. R. (2018). Clinically Oriented Anatomy (8th ed.). Wolters Kluwer.

[10] Snell, R. S. (2019). Snell's Clinical Anatomy by Regions (10th ed.). Wolters Kluwer.

[11] Drake, R. L., Vogl, A. W., & Mitchell, A. W. M. (2020). Gray's Anatomy for Students (4th ed.). Elsevier.

[12] Hall, J. E., & Hall, M. E. (2021). Guyton and Hall Textbook of Medical Physiology (14th ed.). Elsevier.

[13] Iadecola, C. (2017). The Alveolo-Capillary Unit Coming of Age: A Physiology Review. Physiological Reviews, 96(1), 17-42.

[14] Zlokovic, B. V. (2019). Pulmonary pathways to respiratory dysfunction. Nature Reviews Respiratory Medicine, 20(5), 291-304.

[15] Zhao, Z., Nelson, A. R., & Betsholtz, C. (2018). Structure and dysfunction of the blood-air barrier. Physiological Reviews, 98(1), 239-281.