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БИОМЕДИЦИНА ВА АМАЛИЁТ ЖУРНАЛИ

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ABSTRACT

In recent years, patient expectations regarding the outcomes of refractive surgery have significantly increased. Achieving high visual acuity alone is no longer sufficient; subjective visual quality under various lighting conditions is becoming increasingly important. One of the key factors influencing visual perception after laser vision correction is optical aberrations, particularly higher-order aberrations.. The aim of the study is to investigate the changes in aberrations occurring after laser vision correction (LASIK) and to evaluate their impact on visual quality

Keywords: LASIK, higher-order aberrations, visual quality, spherical aberration

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ИЗМЕНЕНИЯ АБЕРРАЦИЙ И ИХ ВЛИЯНИЕ НА ЗРЕНИЕ ПОСЛЕ LASIK

АННОТАЦИЯ

В последние годы требования пациентов к результатам рефракционной хирургии существенно возросли. Недостаточно просто достигнуть высокой остроты зрения; всё большее значение приобретает субъективное качество зрения в различных условиях освещения. Одним из ключевых факторов, влияющих на зрительное восприятие после лазерной коррекции зрения, являются оптические aberrации, особенно aberrации высокого

порядка. Целью исследования является изучение изменений аберраций, возникающих после лазерной коррекции зрения (LASIK), и оценка их воздействия на качество зрения.

Ключевые слова: LASIK, аберрации высокого порядка, качество зрения, сферическая аберрация.

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LASIKDAN KEYINGI ABERRATSIYALARDA KO‘ZDAGI O‘ZGARISHLAR VA ULARNING KO‘RISHGA TA‘SIRI

ANNOTATSIYA

So‘nggi yillarda refraksiya jarrohlik natijalariga bo‘lgan bemorlar talablari sezilarli darajada oshdi. Faqatgina yuqori ko‘rish o‘tkirlikiga erishish emas, turli yoritish sharoitlarida subyektiv ko‘rish sifati tobora muhim ahamiyat kasb etmoqda. Lazer yordamida ko‘rishni tuzatishdan keyingi ko‘rish qobiliyatiga ta‘sir qiluvchi asosiy omillardan biri bu optik aberratsiyalar, ayniqsa, yuqori tartibli aberratsiyalardir.

Kalit so‘zlar: LASIK, yuqori tartibli aberatsiyalar, ko‘rish sifati, sferik aberatsiya.

Ko‘rishni jarrohlik yo‘li bilan tuzatishning LASIK (Laser-Assisted in Situ Keratomileusis) usuli hozirgi kunda refraksiya nuqsonlarni — miopiya, giperopiya va astigmatizmni bartaraf etishda eng keng qo‘llaniladigan va klinik jihatdan samarali usullardan biri bo‘lib qolmoqda. Ushbu metod yuqori aniqlik, natijalarning barqarorligi, qisqa reabilitatsiya davri hamda operatsiyadan keyingi past darajadagi noqulaylik kabi afzalliklari tufayli keng tarqalgan [1]. Biroq, rejalashtirilgan ko‘rish aniqligiga erishilganiga qaramay, barcha bemorlar ko‘rish sifatidan to‘liq qoniqish hosil qilmaydilar. So‘nggi yillarda bemorlarning refraktiv jarrohlik natijalariga bo‘lgan talablari sezilarli darajada oshdi. Endilikda faqat yuqori ko‘rish aniqligini ta‘minlash yetarli emas; turli yorug‘lik sharoitlarida, ayniqsa sust yoritilgan muhitda, shom paytida yoki tunda avtomobil boshqarishda subyektiv ko‘rish sifatining ahamiyati ortib bormoqda [2]. LASIKdan keyingi ko‘rish sifatini belgilovchi asosiy omillar orasida optik aberatsiyalar, xususan yuqori tartibli aberatsiyalar (Higher-Order Aberrations, HOA) — sferik aberatsiya va koma kabi turlarga alohida e‘tibor qaratilmoqda. Oddiy sharoitlarda bu kabi optik buzilishlar sezilmaydi, biroq operatsiyadan so‘ng ular kuchayib, yorug‘lik manbalari atrofida halolar, porlashlar (glare), tasvirning aniqligi va kontrasti pasayishi kabi vizual simptomlarga sabab bo‘lishi mumkin [4]. Bunday holatlar har doim ham standart ko‘rish tekshiruvlari orqali aniqlanmaydi, bu esa ularning diagnostikasi va tahlilini dolzarb qiladi. LASIK texnologiyasining tanlanishi ham katta ahamiyatga ega, chunki ro‘g‘a (kornea) ablyatsiyasining turli algoritmlari induktsiyalangan aberatsiyalar darajasiga sezilarli ta‘sir ko‘rsatadi. Standart, shaxsiylashtirilmagan LASIK dasturlari ko‘pincha ko‘zning individual optik xususiyatlarini hisobga olmaydi, bu esa yuqori tartibli aberatsiyalar ortishiga olib keladi [3]. Natijada, ayniqsa katta qorachiq diametriga ega bemorlarda, vizual noqulaylik kuzatiladi. Zamonaviy wavefront va aberrometriya tizimlari (masalan, iTrace) yordamida olingan ma‘lumotlar shuni ko‘rsatadiki, standart LASIK operatsiyasidan so‘ng yuqori tartibli aberatsiyalar sezilarli darajada ortadi va bu holat uzoq muddat davomida saqlanib qoladi.

Tadqiqot maqsadi. Ushbu tadqiqotning maqsadi — LASIK jarrohligidan keyin yuzaga keladigan aberatsiyalar o‘zgarishini o‘rganish hamda ularning ko‘rish sifatiga ta‘sirini baholashdan iborat.

Materiallar va metodlar. Tadqiqot Respublika ixtisoslashtirilgan ko‘z mikroxirurgiyasi ilmiy-amaliy tibbiyot markazida (RIXM IAMT) zamonaviy aberatsiyalar diagnostikasi usullari yordamida, operatsiyadan oldin va keyin o‘tkazildi. Tadqiqot ob‘ekti sifatida LASIK operatsiyasidan

o'tgan miopiya bemorlar tanlandi. Tadqiqot prospektiv klinik xususiyatga ega bo'lib, standart LASIK usuli yordamida lazerli ko'rish korreksiyasidan so'ng ro'g'a (kornea)ning yuqori tartibli aberatsiyalari o'zgarishi va ularning ko'rish funksiyalariga ta'sirini baholashga qaratilgan edi. Tadqiqotga quyidagi bemorlar kiritildi: 28 nafar bemor (56 ta ko'z), yoshi 20 dan 36 yoshgacha. Yengil va o'rta darajadagi miopiya (-6,0 D gacha) tashxisi bilan; Hamroh ko'z patologiyasi bo'lmagan; Muntazam ro'g'a astigmatizmiga ega; Ilgari oftalmologik operatsiya o'tkazmagan shaxslar.

LASIK operatsiyalari Teneo (Bausch + Lomb) ekssimer lazer tizimi yordamida bajarildi. Ablyatsiya standart protokol asosida, 6,0–6,5 mm optik zonada amalga oshirildi. Bemorlar quyidagi kompleks oftalmologik tekshiruvlardan o'tkazildi — operatsiyagacha, shuningdek LASIKdan 1 va 3 oy o'tgach: Ko'rish aniqligini aniqlash (korreksiyasiz va korreksiya bilan); Aberrometriya: ro'g'a aberatsiyalari (Zernike 3- va 4-darajali komponentlari) Pentacam AXL yordamida tahlil qilindi;

Kontrast sezgirlik: Topcon CC-100 HW6.0 qurilmasida turli fazoviy chastotalarda baholandi; So'rovnomalar: subyektiv ko'rish sifatini baholash uchun odifikatsiyalangan vizual simptomlar shkalasi (tunda ko'rish, halolar, bliqlar, yorug'lik sezuvchanligi va boshqalar) qo'llanildi. Statistik tahlil: ma'lumotlar juft t-test yordamida operatsiyagacha va keyingi ko'rsatkichlar o'rtasida taqqoslandi. Kontrast sezgirlik bilan sferik aberatsiya o'rtasidagi bog'liqlik Pirson korrelyatsiya koeffitsienti orqali baholandi. $p < 0,05$ qiymatlar statistik ahamiyatli deb hisoblandi.

Natijalar

Operatsiyadan 1 oy o'tgach, barcha bemorlarda korreksiyasiz ko'rish aniqligi (UCVA) barqarorlashdi va o'rtacha $0,9 \pm 0,1$ ni tashkil etdi (operatsiyadan oldin: $0,2 \pm 0,1$). Ko'pchilikda korreksiya bilan ko'rish aniqligi (BCVA) o'zgarishsiz qoldi yoki bir qatordan yaxshilanish kuzatildi. BCVA pasayishi holatlari qayd etilmadi.

Aberrometriya natijalari LASIK operatsiyasidan so'ng yuqori tartibli aberatsiyalar (HOA) ko'rsatkichlarining ishonchli oshishini ko'rsatdi (jadval 1).

1-jadval.

Yuqori tartibli aberatsiyalar ko'rsatkichlari (o'rtacha qiymat ± standart og'ish)

Ko'rsatkich	LASIKdan oldin	1 oy o'tgach	3 oy o'tgach
(o'rt. ± SD)			
RMS HOA (5 mm qorachiq), mkm	$0,23 \pm 0,08$	$0,37 \pm 0,10$	$0,35 \pm 0,09$
Sferik aberatsiya (Z4(0))	$0,04 \pm 0,02$	$0,14 \pm 0,03$	$0,13 \pm 0,02$
Vertikal koma (Z3(-1))	$0,04 \pm 0,02$	$0,08 \pm 0,03$	$0,07 \pm 0,03$

Yuqori tartibli aberatsiyalarning o'rtacha kvadratik qiymati (RMS HOA) operatsiyagacha $0,23 \pm 0,08$ mkm ni tashkil etgan. LASIKdan bir oy o'tgach, ushbu ko'rsatkich $0,37 \pm 0,10$ mkm gacha sezilarli oshdi ($p < 0,05$), bu esa jarrohlik aralashuvi natijasida optik buzilishlarning ortganini ko'rsatadi. Uch oy o'tgach, RMS HOA biroz kamayib, $0,35 \pm 0,09$ mkm ni tashkil etdi, biroq u operatsiyagacha bo'lgan nazorat darajasidan ancha yuqori bo'lib qoldi ($p < 0,05$). Sferik aberatsiya (Z4(0)) eng sezilarli o'zgarishlarni ko'rsatdi: operatsiyagacha $0,04 \pm 0,02$ mkm, operatsiyadan bir oy o'tib $0,14 \pm 0,03$ mkm gacha oshdi ($p < 0,01$) va uchinchi oyda $0,13 \pm 0,02$ mkm ni tashkil etdi ($p < 0,01$). Bu natijalar LASIK operatsiyasining ko'zning optik tizimi shakliga sezilarli ta'siri va ayniqsa past yoritilgan sharoitlarda ko'rish sifatiga salbiy ta'siri bo'lishi mumkinligini ko'rsatadi. Vertikal koma (Z3(-1)) ham $0,04 \pm 0,02$ mkm dan $0,08 \pm 0,03$ mkm gacha oshdi ($p < 0,05$) va uch oyda $0,07 \pm 0,03$ mkm gacha biroz kamaydi ($p < 0,05$), biroq boshlang'ich darajadan yuqori holatda saqlanib qoldi.

Kontrast sezgirlik Topcon CC-100 HW6.0 qurilmasi yordamida vertikal panjaralar bo'yicha fazoviy chastotalar 3, 6, 12 va 18 sikl/burchak daraja (cpd) da, fotopik va mezopik yoritilish sharoitlarida baholandi. Fotopik sharoitlarda kontrast sezgirlikdagi o'zgarishlar ahamiyatsiz edi.

Mezopik sharoitlarda esa, bir oy o‘tgach, yuqori fazoviy chastotalarda (12 va 18 cpd) kontrast sezgirlikning pasayishi kuzatildi, bu esa sferik aberatsiyaning ortishi bilan ishonchli korrelyatsiya ko‘rsatdi ($r = 0,58$; $p < 0,01$).

2-jadval.

Kontrast sezgirlik ko‘rsatkichlari.

Fazoviy chastota (tsikl/daraja)	LASIKgacha (logCS)	1 oy o‘tib	3 oy o‘tib
3	1,86	1,75	1,83
6	1,71	1,52	1,68
12	1,40	1,20	1,40
18	1,20	1,00	1,10

Sub’yektiv simptomlar. Operatsiyadan 1 oy o‘tganida bemorlarning 32 foizi tungi paytda galo (yorug‘lik atrofidagi halqalar) va porlash (blik) kabi shikoyatlarni bildirgan. 3-oyga kelib bu holatlar sezilarli kamayib, 12 foiz bemorlarda saqlanib qoldi. Bunday ko‘rish simptomlari kuchli bo‘lgan bemorlarda sferik aberatsiya ko‘rsatkichlari yuqoriroq bo‘lgani aniqlandi ($r = 0,62$, $p < 0,01$).

Muhokama. Tadqiqot natijalari shuni ko‘rsatdiki, standart LASIK usuli bilan bajarilgan ko‘rish korreksiyasidan so‘ng yuqori tartibli aberatsiyalar, ayniqsa sferik aberatsiya va darajalari oshadi. LASIKdan keyingi RMS HOAs (yuqori tartibli aberatsiyalarning o‘rtacha kvadratik qiymati) ko‘rsatkichlarining oshishi barqaror xarakterga ega bo‘lib, operatsiyadan kamida uch oy o‘tganidan so‘ng ham saqlanib qoldi. Ayniqsa sferik aberatsiyaning ortishi, yuqori fazoviy chastotalarda kontrast sezgirlikning pasayishi bilan o‘zaro bog‘liqlikda (korrelyatsiyada) kuzatildi. Bu holat shuni anglatadiki, bemorlar ko‘rish o‘tkirliyi yuqori darajada saqlangan bo‘lishiga qaramay, past yoritilgan sharoitlarda ko‘rish sifatining sub’yektiv yomonlashuvini his qilishlari mumkin. Topcon CC-100 HW6.0 qurilmasi yordamida 12 va 18 tsikl/daraja fazoviy chastotalarda kontrast sezgirlikning kamayishi obyektiv tarzda qayd etildi, bu esa aynan aberatsion buzilishlarga sezgir ko‘rsatkichlar ekanligini tasdiqlaydi. Qizig‘i shundaki, 3-oyga kelib kontrast sezgirlikning qisman tiklanishiga qaramay, ayrim bemorlarda qoluvchi shikoyatlar (galo, blik) saqlanib qoldi. Bu holat shuni ko‘rsatadiki, lazerli korreksiya rejalashtirilayotganda nafaqat refraksion ko‘rsatkichlar, balki ko‘zning optik xususiyatlari ham hisobga olinishi zarur.

Xulosa. Standart LASIK operatsiyasi ro‘da yuqori tartibli aberatsiyalarining, xususan sferik aberatsiya va vertikal komaning sezilarli darajada ortishiga olib keladi. Yuqori tartibli aberatsiyalarning ortishi mezopik sharoitlarda (sust yoritilgan muhitda) yuqori fazoviy chastotalardagi kontrast sezgirlikning pasayishiga sabab bo‘ladi, bu esa ko‘rish o‘tkirliyi yuqori bo‘lishiga qaramay ko‘rish sifatiga ta’sir ko‘rsatadi. Shunday qilib, olingan ma’lumotlar ko‘rish o‘tkirligini baholash bilan bir qatorda ko‘rish sifatini ham tahlil qilish zarurligini ko‘rsatadi. Ayniqsa, tungi va past yoritilgan sharoitlarda ishlaydigan kasb egalari uchun bu omil alohida ahamiyat kasb etadi.

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