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◇临床医学◇

飞秒制瓣准分子激光原位角膜磨镶术和前弹力层下激光角膜磨镶术术后角膜前表面高阶相差变化的比较

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摘要:目的 比较飞秒制瓣准分子激光原位角膜磨镶术(FS-LASIK)和机械刀辅助的前弹力层下激光角膜磨镶术(SBK)术后角膜前表面高阶像差的变化情况。**方法** 选择2015年9月至2016年8月在宣城市中心医院行角膜屈光手术病人112例,通过随机数字表法分为FS-LASIK的54例病人(54只眼)和行SBK术的58例病人(58只眼),其中每例病人随机数字表法选择1只眼。于术前及术后3个月利用眼前节全景仪(Pentacam HR)测量病人角膜前表面的高阶像差(主要包括总的高阶像差、水平彗差、垂直彗差及球差),高阶像差的描述采用Zernike多项式表示。**结果** FS-LASIK组和SBK组术前病人在年龄、等效球镜度数(SE)、角膜前表面各高阶像差的比较均差异无统计学意义($P>0.05$)。FS-LASIK组术后3个月的角膜前表面总的高阶像差和球差较术前差异有统计学意义($P<0.001$),水平及垂直彗差较术前均差异无统计学意义(P值分别为0.558和0.325)。SBK组术后3个月角膜前表面总的高阶像差、球差($P<0.001$)及垂直彗差($P=0.001$)较术前差异有统计学意义,水平彗差较术前差异无统计学意义($P=0.428$)。FS-LASIK组和SBK组在术后3个月时的总的高阶像差、水平慧差及球差值均差异无统计学意义(P值分别为0.487、0.373和0.063),然而两组之间的垂直彗差差异有统计学意义[FS-LASIK:(−0.03±0.48)μm,SBK:(−0.21±0.42)μm;$P=0.030$]。**结论** FS-LASIK术组与SBK术组在角膜前表面的总高阶像差、水平慧差和球差之间均差异无统计学意义,然而FS-LASIK术后3个月的角膜前表面垂直彗差显著低于SBK组,可能表明在对称性、偏中心、倾斜等方面,飞秒激光制瓣优于机械板层角膜刀制瓣。

关键词:角膜磨镶术,激光原位; 激光,准分子; 角膜波前像差; 像差测量; 飞秒激光; 高阶像差

Comparison of higher-order aberration changes in anterior corneal surface between FS-LASIK and SBK surgery

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Abstract: Objective To make a comparison of higher-order aberration changes in anterior corneal surface between femtosecond laser-assisted keratomileusis (FS-LASIK) and sub-bowman-keratomileusis (SBK surgery). **Methods** One hundred and twelve patients were randomly divided into FS-LASIK gourp and SBK group according to the random number table method. FS-LASIK was performed in 54 eyes of 54 patients, and 58 eyes of 58 patients received mechanical SBK (selected eye was chosen from each of the patients by random number table method). HOAs (included total HOAs, horizontal coma aberration, vertical coma aberration, and spherical aberration) were measured preoperatively, after 3 months postoperatively by Pentacam. The aberrations were described as Zernike polynomials. **Results** There was no significant difference between FS-LASIK group and SBK preoperative patients in age, spherical equivalent (SE), higher-order aberrations of corneal surface ($P>0.05$). Total HOAs and SA increased significantly in 3 months after FS-LASIK ($P<0.001$). However, no significant difference was found in postoperatively vertical coma and horizontal coma ($P=0.558$ & 0.325). Total HOAs, SA ($P<0.001$), and vertical coma ($P=0.001$) showed a significant growth in SBK group. However, there was no significant change in horizontal coma. No significant difference was found between FS-LASIK group and SBK group in postoperatively total HOAs, SA and horizontal coma ($P=0.487$, 0.063 and 0.373, respectively). However, signifcant difference was found in postoperatively vertical coma (FS-LASIK: $-0.03\pm0.48\mu m$; SBK: $-0.21\pm0.42\mu m$; $P=0.030$). **Conclusion** FS-LASIK increased less vertical coma than SBK after 3 months postoperatively which may illustrated that Flaps created by femtosecond laser has more advantages than microkeratome in irregular, decentration, and tilt.

Key words: Keratomileusis, laser in situ; Lasers, excimer; Corneal wavefront aberration; Aberrometry; Femtosecond laser; Higher-order aberrations

自准分子激光角膜切削术(photorefractive keratectomy, PRK)[1]于1983年问世以来,治疗屈光不正由单纯佩戴眼镜矫正逐渐进入了可手术治疗的时代。准分子激光原位角膜磨镶术(1aser in situ keratomileusis, LASIK)因具有适用范围大、术后病人屈光度稳定、视力恢复快、术后反应轻、角膜Haze(角膜上皮下浅层浑浊)发生率较低等优点成为角膜屈光手术中的主流术式[2]。LASIK术术中及术后出现的并发症多与术中角膜瓣的制作相关,因此制作角膜瓣是该手术的关键步骤。与传统LASIK术式相比,前弹力层下原位角膜磨镶术(sub-bowman keratomileusis, SBK)特点是制作角膜瓣的位置位于前弹力层下,保留了前弹力层,对角膜生物力学影响更小,因此更适用于高度近视以及角膜厚度偏薄的病人。随着飞秒激光的引进,飞秒制瓣LASIK(femtosecond laser-assisted laser in situ keratomileusis, FS-LASIK)越来越多被国人所接受[3]。为了比较上述两种制瓣方式术后3个月角膜前表面高阶像差的变化,本研究利用眼前节全景仪(Pentacam)对FS-LASIK组和SBK组术前、术后3个月角膜前表面高阶像差进行了测量及分析。

1 资料与方法

1.1 研究对象 选择2015年9月至2016年8月在宣城市中心医院行FS-LASIK术的54例病人(54只眼)和行SBK术的58例病人(58只眼),其中每例病人通过随机数字表法取1只眼。FS-LASIK组中,男26例,女28例;年龄20~32(23.93±2.92)岁,等效球镜度数-1.75~-7.75(-5.03±1.46)D。SBK组中,男22例,女36例;年龄18~34(24.28±4.83)岁,等效球镜度数-2.75~-11.13(-5.27±1.76)D。两组病人的年龄、等效球镜度数等之间差异无统计学意义($P>0.05$,见表1)。所有病人或其近亲属知情同意,本研究符合一般医学伦理学原则。

1.2 术前检查 所有病人术前均进行常规的眼科检查并排除影响手术的相关眼部及全身各系统性疾病,并行医学验光、眼压、Pentacam HR、角膜地形图、眼底、角膜超声测厚、泪膜影像分析等检查。

1.3 手术方法 术前常规行结膜囊冲洗,消毒,铺洞巾,表面麻醉使用0.5%盐酸丙美卡因,手术贴膜

覆盖睫毛和睑缘,开睑器开睑。FS-LASIK 组采用 Visu Max 飞秒屈光手术系统(Germany,Zeiss Inc.)制作角膜瓣,角膜行激光切削步骤使用美国 VISXS4-IR 准分子激光系统完成。SBK 采用全自动微型板层角膜刀制作角膜瓣,同样使用 VISXS4-IR 准分子激光系统完成角膜激光切削。术后常规处理和检查。所有手术操作均由同一名医师完成。

1.4 高阶像差测量 采用 Pentacam 在术前 1 d、术后 3 个月对病人进行检查,测量角膜前表面直径 6.0 mm 范围内的高阶像差。检查方法:病人放置下颌及额部至正确位置,注视前方仪器内的靶心亮点,聚焦清晰后仪器自动进行扫描,测量 4 次选取成像质量合格的结果并记录取平均值。测量均由一名技术熟练的技师完成。

1.5 统计学方法 采用 SPSS 16.0 统计学分析软件,对于计量资料采用正态性及方差齐性检验,符合正态分布的数据用$\bar{x} \pm s$ 表示,两组间的比较采用两独立样本 t 检验,对于组内术前、术后 3 个月观察指标的比较采用配对 t 检验。对于计量资料不满足正态性或方差齐性检验,两组间的比较采用非参数检验。$P<0.05$ 则认为差异有统计学意义。

2 结果

2.1 两组术前一般资料的比较 术前两组病人年龄、等效球镜度数、角膜前表面各高阶像差的比较,均差异无统计学意义($P>0.05$,见表 1)。

2.2 两组术后高阶像差比较 FS-LASIK 组和 SBK 组术后 3 个月总的高阶像差、水平慧差及球差值均差异无统计学意义($P>0.05$),垂直彗差有明显差异($P=0.030$),见表 2。

3 讨论

高阶像差是评价视觉质量的重要指标之一,术后早期出现的光晕、暗环境下视力下降、以及眩光均与其增加有关[4]。角膜是人眼屈光系统中非常重要的介质之一,角膜像差约占据全眼总像差的 80%。角膜像差主要来源于角膜的前表面[5],Seiler 等[4]通过研究提出 LASIK 术后的角膜前表面高阶像差变化主要与制瓣有关,因角膜瓣的制作和角膜生物力学性能的变化可能诱发高阶像差,从而在一定程度上使屈光手术术后的视觉质量受到影响。然而有文章[6-7]提示 LASIK 术后的角膜前表面高阶像差变化与制瓣方式无关,而与术中角膜基质层的激光消融有关,故关于两种手术方式术后角膜高阶像差比较的文献结果并不一致。

理论上,飞秒激光制作角膜瓣的优势主要是可以根据屈光度、角膜直径、角膜厚度及瞳孔直径的差异而进行个体化的设定。此外,飞秒制瓣的厚度具有更好的精准性、均一性及规整性,可减少机械刀制瓣引起的相关并发症[8-10]。有学者[11-12]认为 FS-LASIK 在角膜各高阶像差的增加方面优于角膜机械刀制瓣 LASIK。Zhang 等[13]发表的 meta 分析结果表明 FS-LASIK 术后角膜前表面总的高阶像差和球差的增加明显小于机械板层角膜刀制瓣 LASIK 手术。然而也有文献[14-15]报道 FS-LASIK 和机械板层角膜刀制瓣 LASIK 术后角膜前表面的高阶像差之间差异无统计学意义。本研究结果表明:FS-LASIK与角膜机械刀制瓣 LASIK 术后角膜前表面的总高阶像差与球差之间均差异无统计学意义,这与 Porter[6]、Calvo[14]等的结果相一致。可能提示术后高阶像差的产生与激光消融相关,而与微型角膜刀制瓣切口无关。

彗差是反映人眼的不规则性、倾斜、偏中心等不对称性,即人眼屈光特性中的非对称性[16]。国外有报导显示偏心瓣膜会使高阶像差增加尤其是彗差[12,17],本研究结果提示 SBK 组在术后 3 个月角膜

表 1 两组屈光不正病人术前一般资料比较/($\mu m, \bar{x} \pm s$)

组别	眼数/只	等效球镜 SE/D	总高阶像差	水平彗差	垂直彗差	球差
SBK 组	58	-5.27 ± 1.76	0.13 ± 0.02	0.01 ± 0.12	-0.04 ± 0.18	0.26 ± 0.08
FS-LASIK 组	54	-5.03 ± 1.46	0.14 ± 0.03	0.01 ± 0.13	0.04 ± 0.22	0.26 ± 0.07
t 值		-0.777	-0.843	-0.217	-1.954	-0.121
P 值		0.439	0.401	0.828	0.053	0.904

表 2 两组屈光不正病人 SBK 和 FS-LASIK 术后 3 个月角膜前表面高阶像差值的比较/($\mu m, \bar{x} \pm s$)

组别	眼数/只	总高阶像差	球差	水平彗差	垂直彗差
SBK 组	58	0.28 ± 0.10[a]	0.50 ± 0.16[a]	-0.04 ± 0.44[b]	-0.21 ± 0.42[c]
FS-LASIK 组	54	0.29 ± 0.09[a]	0.50 ± 0.16[a]	0.04 ± 0.40[d]	-0.03 ± 0.48[e]
t 值		-0.697	-1.879	-0.895	-2.197
P 值		0.487	0.063	0.373	0.030

注:与本组术前比较,[a]$P<0.001$,[b]$P=0.428$,[c]$P=0.001$,[d]$P=0.558$,[e]$P=0.325$

前表面的垂直彗差较术前向负值方向显著增加,而FS-LASIK组术后3个月水平彗差和垂直彗差较术前差异无统计学意义,提示飞秒激光制瓣在偏中心、倾斜、不对称性等方面优于机械板层角膜刀。其原因可能因为:(1)飞秒激光可以随意调整角膜瓣的位置从而使其位于角膜中央,这样就可以很大程度上降低角膜瓣的偏心率;而机械板层刀制作角膜瓣的偏心率受到术者的熟练程度以及病人的配合程度等多种因素的影响;(2)影响高阶像差的重要因素还有角膜瓣的形状和蒂的位置,机械板层刀制作角膜瓣蒂的尺寸大小和厚度通常受到角膜曲率、角膜厚度等的影响而变异较大[18],飞秒激光制作的角膜瓣的形态更圆,角膜瓣大小可以根据具体情况进行调整至与角膜相适应,因此彗差的增加也比机械刀制瓣较小;(3)机械板层刀是水平切削,瓣复位后与眼球基体的固着性不够好;而飞秒激光制作的角膜瓣是嵌入式瓣膜,咬合紧密,复位后更不易错位及移位,从而减少了偏移产生的机会。Chan等[19]通过长达一年的随访观察发现:飞秒制瓣组在术后3个月时,其角膜的球差,慧差及三叶草像差明显低于机械刀制瓣组,然而术后6个月及12个月随访发现上述差异不再明显,这可能提示:随着术后时间的推移,相对机械刀制瓣而言,飞秒制瓣的优势可能消退并在术后6个月逐渐消失。笔者将继续随访观察。

总之,FS-LASIK术组与SBK术组在角膜前表面的总高阶像差、球差及水平慧差之间均差异无统计学意义,然而FS-LASIK术后3个月的角膜前表面垂直彗差显著低于SBK组。说明制瓣在对称性、偏中心、倾斜等方面,飞秒激光制瓣优于机械板层角膜刀制瓣。

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