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手术室温度对FS-LASIK术后结果的影响

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摘 要

目的：探讨手术室温度对飞秒激光制瓣的准分子激光原位角膜磨镶术(Femtosecond laser-assisted *in situ* keratomileusis, FS-LASIK)术后结果的影响。方法：回顾性研究。收集我院2023-05/2023-10行FS-LASIK的病例，抽取年龄、屈光度数、角膜厚度、角膜曲率、手术室湿度差异小，但手术时温度不同的病例分为三组，每组20人40只眼，共60人120只眼。A组手术室温度为20.0℃~20.5℃，B组为22.0℃~22.5℃，C组为24.0℃~24.5℃。手术由同一位手术医生、同样的设备完成，术后统一用药。比较三组术后3个月时裸眼视力与屈光度的差异情况。结果：不同手术温度组在术后3月比较时，未发现裸眼视力及屈光度之间存在统计学差异($P > 0.05$)。三组患者术后3个月裸眼视力、等效球镜度数不满足正态分布，采用Kruskal-Wallis法进行检验。术后裸眼视力比较无统计学意义($H = 2.648$, $P = 0.266$)。三组患者术后等效球镜度数比较无统计学意义($H = 1.010$, $P = 0.604$)。结论：空气中的温度及湿度的明显变化才能对准分子激光能量产生显著影响。湿度可能较温度的影响更大。本文研究结果未发现在设备商推荐温度范围内变化时，对FS-LASIK术后视力屈光度产生有统计学意义的显著影响。

关键词

手术室温度，手术室湿度，飞秒激光制瓣的准分子激光原位角膜磨镶术

The Effect of Operating Room Temperature on FS-LASIK Outcomes

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Abstract

Aim: To explore the effect of operating room temperature on the postoperative outcomes of femto-

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second laser-assisted *in situ* keratomileusis (FS-LASIK). Methods: Retrospective study. Collecting cases that underwent FS-LASIK in our hospital from May 2023 to October 2023, cases were extracted with small differences in age, diopters, corneal thickness, corneal curvature, and operating room humidity. Cases with different temperatures during surgery were divided into three groups. Each group has 20 people with 40 eyes, a total of 60 people with 120 eyes. The operating room temperature in group A was 20.0˚C~20.5˚C, in group B was 22.0˚C~22.5˚C, and that in group C was 24.0˚C~24.5˚C. The surgery was completed by the same surgeon and the same equipment, and the same postoperative medication was used. The differences in naked eye visual acuity and diopters between the three groups were compared 3 months after surgery. Results: Comparing different surgical temperature groups 3 months after surgery, no statistical difference was found between naked eye visual acuity and diopters ($P > 0.05$). The naked visual acuity and spherical equivalent refraction of the three groups 3 months after surgery did not satisfy the normal distribution, and the Kruskal-Wallis method was used to test. There was no statistical significance in postoperative naked eye visual acuity ($H = 2.648$, $P = 0.266$). There was no statistical significance in the postoperative spherical equivalent refraction of the three groups ($H = 1.010$, $P = 0.604$). Conclusion: Only significant changes in temperature and humidity in the air can have a significant impact on excimer laser energy. Humidity may have a greater impact than temperature. The results of this study did not find that changes in the temperature range recommended by the equipment manufacturer have a statistically significant impact on the visual acuity and diopters after FS-LASIK.

Keywords

Operating Room Temperature, Operating Room Humidity, Femtosecond Laser-Assisted *in Situ* Keratomileusis

1. 引言

飞秒激光制瓣的准分子激光原位角膜磨镶术(FS-LASIK)手术期间的影响因素众多，包括眼表干眼情况、不同手术医生、不同手术设备、患者术中配合情况、患者年龄、屈光度数、角膜厚度、角膜曲率、手术室温度湿度、外部环境温湿度、海拔气压等等[1]-[13]。在 FS-LASIK 中，准分子激光通过消融角膜基质，从而改变角膜屈光度。与飞秒激光小切口角膜基质透镜取出术(Femtosecond laser small incision lenticule extraction)直接接触角膜进行扫描不同[14]，准分子激光要先透过角膜上方的空气才到达角膜，空气的温度与湿度可能会吸收部分激光能量，以及对角膜消融基质面的干燥程度产生影响，从而对术后视力屈光度产生影响[15]。Mimouni 等人报告表明[16]，环境温度或湿度确实可能对 LASIK 后的屈光结果产生临床影响，在其 41,504 只眼睛的观察研究中发现二次手术组术中湿度较高、而温度较低。一项针对超过 200,000 只眼睛的回顾性研究显示，手术室温度和湿度对术后结果没有显著影响[17]。基于目前尚无明确结论，环境温度或湿度是否会影响 FS-LASIK 术后屈光结果，故设计本研究进一步探讨 FS-LASIK 手术期间手术室温度是否对屈光结果有临床显著影响。

2. 对象和方法

2.1. 对象

采用回顾性研究。收集我院 2023-05/2023-10 行 FS-LASIK 的病例，抽取年龄、屈光度数、角膜厚度、

角膜曲率、手术室湿度差异小，但手术室温度不同的病例。将手术时不同温度的病例分为三组，每组 20 人 40 只眼。A 组手术室温度为 20.0℃~20.5℃，B 组为 22.0℃~22.5℃，C 组为 24.0℃~24.5℃。比较三组术后 3 个月时裸眼视力、屈光度的变化差异情况。所有患者由同一位手术医生完成手术，均为 Visumax 设备(Carl Zeiss Meditec, Germany)制作角膜瓣，角膜瓣扫描参数点间距与行间距均设置为 4.5 um，角膜瓣侧切口点间距与行间距均为 2.0 um，侧切角度为 90˚，角膜蒂位于上方 90˚位置，蒂宽度 4 mm，能量设置为 34 (即 170 nJ)。Schwind Amaris 1050 RS (SCHWIND eye-tech-solutions, Germany)设备进行准分子切削，切削直径较角膜瓣直径小 0.1~0.2 mm。本研究遵循《赫尔辛基宣言》要求，通过了我院伦理委员会审定。

2.2. 方法

三组患者均行视力、眼压、验光单、裂隙灯显微镜和角膜地形图检查。各组术后统一用药。观察术后 3 个月三组裸眼视力、屈光度变化情况。测得的小数视力转换为最小分辨角对数视力(logMAR)单位，屈光度以等效球镜度数(spherical equivalent, SE)、角膜曲率以平均曲率进行统计分析。

统计学分析：所有统计数据用 SPSS 24.0 软件进行统计学处理，计量资料采用均数 ± 标准差($\bar{x} \pm s$)表示，并采用 Kolmogorov-Smirnova 法进行正态分布检验，对满足正态分布的多组数据采用单因素方差分析(ANOVA)法进行检验，对于不满足正态分布的多组数据采用 Kruskal-Wallis 法进行检验。计数资料采用卡方检验。以 $P < 0.05$ 作为差异有统计学意义。

3. 结果

3.1. 三组患者术前一般资料比较

本研究共纳入 60 例 120 眼，其中男 15 例女 45 例，年龄 19~38 (26.5 ± 4.7)岁，等效球镜度数为−2.00 到−8.50 (−4.9 ± 1.3) D，角膜厚度 492~606 (545.6 ± 26.3) um，角膜平均曲率 39.9~46.6 (43.6 ± 1.2) D，湿度 37~43 (38.9 ± 1.2)%。三组数据除术前 SE、角膜厚度、曲率满足正态分布外其他数据不满足正态分布。根据手术室温度不同分为三组，三组一般资料详细见表 1，除温度外，三组患者其他术前一般资料比较差异无统计学意义($P > 0.05$)。

Table 1. Comparison of preoperative general data among the three groups
表 1. 三组患者术前一般资料比较

组别	男/女 (例)	温度 ($\bar{x} \pm s$, ˚C)	湿度 ($\bar{x} \pm s$, %)	年龄 ($\bar{x} \pm s$，岁)	术前 SE ($\bar{x} \pm s$, D)	角膜厚度 ($\bar{x} \pm s$, um)	角膜曲率 Km ($\bar{x} \pm s$, D)
A 组	4/16	20.4 ± 0.1	39.0 ± 1.2	26.2 ± 5.4	−4.8 ± 1.4	547 ± 30.3	43.7 ± 1.2
B 组	6/14	22.3 ± 0.1	38.9 ± 1.1	26.6 ± 3.8	−4.7 ± 1.1	541 ±21.0	43.6 ± 1.2
C 组	5/15	24.2 ± 0.1	38.8 ± 1.4	26.8± 4.9	−5.0 ± 1.3	547 ± 27.0	43.5 ± 1.1
$X^2/H/F$	0.533	106.9	0.417	0.809	0.597	0.578	0.351
P	0.766	0.000	0.812	0.667	0.552	0.562	0.705

3.2. 三组患者术后结果比较

三组患者术后 3 个月裸眼视力、等效球镜度数不满足正态分布，采用 Kruskal-Wallis 法进行检验。术后裸眼视力比较无统计学意义($H = 2.648$, $P = 0.266$)。三组患者术后等效球镜度数比较无统计学意义($H = 1.010$，$P = 0.604$，见表 2)。

Table 2. Comparison of postoperative naked eye visual acuity and diopter among the three groups
表 2. 三组患者手术术后裸眼视力及屈光度比较

($\bar{x} \pm s$, LogMAR, D)

组别	术后 3 月裸眼视力	术后 3 月 SE
A 组	−0.10 ± 0.07	−0.14 ± 0.26
B 组	−0.10 ± 0.05	−0.10 ± 0.29
C 组	−0.12 ± 0.05	−0.08 ± 0.27
H	2.648	1.010
P	0.266	0.604

4. 讨论

我们的回顾性研究不支持手术室温度与 FS-LASIK 术后结果之间存在临床显著关系。与 Seider 等人[17]的报告一致，其报道在超过 200,000 只眼睛中，手术室温度和湿度与 LASIK 术后屈光度变化没有临床显著关系，手术室温度需要改变 10.4℃，湿度改变 58.4%，才能导致术后预测屈光度变化 0.5 D。与 Randleman 等人[18]的结果一致，他们报告说，在接受 LASIK 或 PRK 的 853 只眼睛中，二次增效手术的发生率与手术室温度湿度无关。在建模实验中，报道温度变化对激光能量没有显著影响，湿度的变化对激光能量有显著影响[19]。

Walter 等人[20]评估了 368 只接受过 LASIK 手术的眼睛，发现手术室湿度和温度与术后屈光结果程度相关，该研究还发现室外温度和湿度与 LASIK 结果的相关性比手术室环境更强。考虑为室外温湿度可能会改变角膜含水量，从而影响准分子激光对角膜切削的精确性[21] [22]。但其他研究中，患者在不同季节分别进行 LASIK 手术，结果表明外部温湿度对 LASIK 术后屈光度数可能产生影响，但对 LASIK 术后视力没有发现临床相关性[23] [24]。在另一份报告中，De Souza 等人[25]评估了 237 只接受过 LASIK 手术的眼睛，并表明手术室的温度和湿度可能影响了他们的术后屈光结果，湿度的影响可能较温度更大。

从理论上讲，温度与湿度的升高会衰减准分子激光的能量，即在温暖潮湿的环境中会导致屈光手术中矫正不足，而在干燥和寒冷的环境中，导致矫正过度[1]。但 Wernli 等人[26]在不同温度下测试准分子激光切削聚甲基丙烯酸甲酯的情况，当温度从 10.1℃上升到 75.7℃时，切削深度从 73.9 um 线性增加到 96.3 um。建模实验中[19]，在低温和高湿度下，猪角膜组织的消融效率降低；环境温度和湿度的变化可能会吸收 10%~14%的激光能量，从而降低应用于角膜基质上的激光能量。这可能是由于环境中潮湿的空气导致较高的 193 nm 紫外线能量被吸收[27]。

Schwind Amaris 1050 RS 准分子激光设备制造商建议环境温度为 18℃~24℃，湿度为 35%~45%下进行工作。本文的局限性在于病例数较少，所有病例皆在基本都在推荐温度范围内进行手术，温差波动较小，无太多推荐温度之外的病例进行对比研究。温差波动较小可能并未导致明显的激光能量变化，故而未发现明显的术后视力屈光度变化。后续可进一步扩大样本量及温差范围，探讨温度对准分子激光能量的影响。

5. 结论

综上所述：空气中的温度及湿度的明显变化才能对准分子激光能量产生显著影响，湿度可能较温度的影响更大。本文研究结果未发现在设备商推荐温度范围内变化时，对 FS-LASIK 术后视力屈光度产生有统计学意义的显著影响。

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