中文摘要

不同年龄近视患者 SMILE 手术前后双眼视功能分析

目的：

观察不同年龄组近视患者飞秒激光小切口角膜基质透镜取出术（small incision lenticule extraction surgery ，SMILE）前后双眼视功能的变化，并分析其临床意义，以期对日后手术设计以及术后指导视功能训练、改善视疲劳等视觉症状提供一定的参考意义。

方法：

回顾性临床研究。选取 2022 年 3 月至 2022 年 9 月期间于吉林大学第二医院行 SMILE 手术的近视患者 82 例（164 眼），年龄 18 岁~ 48 岁（21.46±2.88 岁），术前等效球镜度（spherical equivalent , SE）为−9.38D ~ −1.25D（−5.27±1.71D），双眼 SE 差值<2.50D，术前最佳矫正视力≥5.0。根据患者年龄分为 3 组：A 组：18≤年龄＜28 岁，共 37 例（74 眼）；B 组：28≤年龄＜38 岁，共 28 例（56 眼）；C 组：38≤年龄≤48 岁，共 17 例（34 眼）。所有患者在术前、术后 1 个周、1 个月和 3 个月接受眼科常规检查及双眼视功能检查。双眼视功能检查主要包括调节功能参数如正负相对调节（negative/positive relative accommodation , NRA/PRA），调节幅度（amplitude of accommodation , AMP），调节反应（binocular cross-cylinder , BCC），双眼调节灵敏度（binocular accommodative facility , BAF）；聚散功能如调节性集合 / 调节比值（accommodation convergence/accommation , AC/A），正负融像性聚散（negative/positive fusional vergence , NFV/PFV），远近水平隐斜（distance lateral phoria / near lateral phoria , DLP/NLP）等指标，并填写视疲劳调查问卷。组内手术前后不同时间点数据的比较采用重复测量方差分析，组间数据比较采用双因素重复测量方差分析及 LSD-t 检验， 以 P＜0.05 表示差异有统计学意义。分析讨论不同年龄组近视患者 SMILE 手术前后双眼视功能各项指标的变化。

结果：

1.调节功能组内比较：A 组 NRA 与 AMP 手术前后的差异具有统计学意义（P<0.05）。NRA 术后各时间点均较术前升高；AMP 术后 1 周低于术前，术后 1 月回升，术后 3 月高于术前水平。B 组 NRA、PRA 与 AMP 手术前后的变

化具有统计学意义（P<0.05）。其中 NRA 术后较术前升高；PRA 术后早期下降，术后 3 月较术前增加；AMP 术后 1 周下降，术后 1 月开始回升，术后 3 月逐渐恢复甚至略超过术前水平。C 组 AMP 手术前后变化具有统计学意义（P<0.05），表现为术后早期下降，术后 3 月逐渐恢复甚至超过术前水平。其余调节功能相关指标组内差异无统计学意义。

2.调节功能组间比较： PRA、AMP、BAF 随时间变化的组间差异具有统计学意义（F 组间=6.073，P =0.006；F 组间=11.156，P=0；F 组间=3.332，P =0.048）。PRA 在手术前后各时间点平均值表现为：A 组>B 组>C 组，并且 A 组和 B 组差距相较 B 组和 C 组小，说明 37 岁以上的患者调节能力有更显著的下降。虽然三组术后 3 月 PRA 值较术前均有不同程度的增加，但三组的变化趋势略有不同，A 组术后 1 周即开始增加，而 B 组和 C 组术后早期先下降，之后开始逐渐增加，术后 3 月略超过术前水平。AMP 手术前后各时间点平均值：A 组>B 组>C 组，且三组的变化趋势基本一致。BAF 手术前后各时间点平均值：A 组>B 组>C 组，但三组变化趋势略有不同。其余调节功能相关指标组间差异均无统计学意义。

3.聚散功能组内比较：A 组聚散功能指标中 NPC 破裂值及恢复值、远负融像破裂点、远正融像破裂点手术前后的变化具有统计学意义（P <0.05）。其中 NPC 破裂值及恢复值术后较术前增加。远负融像破裂点、远正融像破裂点术后各时间点均低于术前，并且两指标术后均逐渐接近正常值。B 组聚散功能指标中 NPC 破裂值及恢复值，远正融像破裂点，近负融像模糊点及破裂点，近正融像模糊点、破裂点及恢复点手术前后变化具有统计学意义（P <0.05）。NPC 破裂值及恢复值较术前增加。远正融像破裂点，近负融像模糊点及破裂点，近正融像模糊点、破裂点及恢复点在术后各时间点均低于术前并且逐渐接近正常值。C 组聚散功能指标中 NPC 恢复值，远正融像模糊点及破裂点，近负融像破裂点，近正融像破裂点手术前后变化具有统计学意义（P <0.05）。其中 NPC 恢复值较术前增加。远正融像模糊点及破裂点，近负融像破裂点，近正融像破裂点术后 3 月较术前降低并逐渐接近正常值。

4.聚散功组间比较：聚散功能各相关指标 AC/A , NPC , NFV/PFV 模糊点、破裂点及恢复点手术前后的组间差异均无统计学意义。

5.SMILE 手术前后视疲劳得分的组内及组间差异均无统计学差异。但三组视疲劳总分的变化趋势基本一致，即术后 1 周视疲劳得分均值较术前增加，随后下降，术后 3 月低于术前水平。

结论：

1.SMILE 手术在显著降低屈光度及提高视力的同时，对不同年龄组近视患者的调节功能均有改善作用，并且在年轻组更为显著。

2.SMILE 术后，不同年龄组近视患者的聚散功能也有不同程度的改善，但大部分聚散功能指标的组间差异无统计学意义，说明本研究纳入患者的年龄对 SMILE 手术前后聚散功能的影响不大。

3.SMILE 术后早期视疲劳总分的均值增加，随后下降，术后 3 月低于术前水平。尽管手术前后随时间变化的差异没有统计学意义，但视疲劳得分的变化趋势仍能说明从远期来看，SMILE 手术可能对视疲劳有改善作用。

关键词：

年龄，飞秒激光小切口角膜基质透镜取出术，调节，聚散，双眼视功能

Abstract

Analysis of binocular visual function before and after SMILE in myopic patients of different ages

Purpose:

To observe the changes of binocular visual function before and after Small incision lenticule extraction surgery (SMILE) in myopic patients of different ages and analyze the clinical significance，in order to provide some reference significance for surgical design and postoperative visual function training to improve visual symptoms such as visual fatigue.

Method:

Retrospective clinical study. Eighty-two patients (164 eyes) with myopia corrected by SMILE in the second hospital of Jilin University from March 2022 to September 2022 were included. The age ranged from 18 to 48 years (21.46±2.88 years), and the preoperative spherical equivalent (SE) ranged from −9.38 D to −1.25 D（−5.27±1.71D）. Patients were divided into three groups according to their age: Group A: 37 patients (74 eyes)， 18≤ age <28 years old; Group B: 28 patients (56 eyes) , 28≤ age <38 years old; Group C: 17 patients (34 eyes), 38≤ age ≤48 years old. All patients underwent routine ophthalmological examination and binocular visual function examination before surgery, 1 week, 1 month and 3 months after surgery. Binocular visual function examination parameters mainly include accommodative function such as negative/positive relative accommodation (NRA/PRA), amplitude of accommodation (AMP), binocular cross-cylinder (BCC), binocular accommodative facility (BAF); vergence function such as accommodation convergence/accommation (AC/A) and negative/positive fusional vergence (NFV/PFV), distance lateral phoria / near lateral phoria (DLP/NLP), and filled in the questionnaire of asthenopia at the same time. The differences of data at different time points before and after surgery within the groups were performed by using

repeated measurement analysis of variance and the differences of data among the groups were examined by using two-factor repeated measurement analysis of variance and LSD-t test. $P< 0.05$ was considered that the differences were statistically significant. To analyze and discuss the changes of binocular visual function in myopia patients of different ages before and after SMILE operation.

Results:

1. Comparison of accommodative function within groups: The changes of NRA and AMP in group A before and after operation were statistically significant ($P <0.05$). NRA increased after operation compared with preoperatively. AMP decreased 1 week， increased 1 month after operation, and exceeded preoperative level 3 months after operation. The changes of NRA, PRA and AMP in group B before and after operation were statistically significant ($P <0.05$). NRA increased after operation compared with preoperatively. PRA decreased early after operation and increased 3 months after operation; AMP decreased 1 week after operation, increased 1 month after operation, and even slightly exceeded the preoperative level 3 months after operation. The changes of AMP in group C before and after operation were statistically significant ($P <0.05$), which showed that AMP decreased early after operation and gradually exceeded the preoperative level 3 months after operation. There was no statistical difference in other parameters related to accommodative function within groups.

2. Comparison of accommodative function among groups: There were significant statistical differences among three groups in the changes of PRA, AMP and BAF ($F =6.073$, $P = 0.006$; $F =11.156$, $P = 0$; $F =3.332$, $P =0.048$). The average value of PRA at each time point before and after surgery was group A > group B > group C, and the gap between group A and group B is smaller than that between group B and group C. It could be seen that the accommodative function of patients over 37 years old has decreased more significantly. Although PRA in the three groups all increased 3 months after operation compared with the preoperative period, the change trends were slightly different. The PRA in group A increased 1 week after operation, while PRA in group B and group C decreased early after operation, then gradually

increased, slightly exceeded 3 months after operation. The average value of AMP at each time point before and after operation was group A > group B > group C. The average value of BAF at each time point before and after operation was group A > group B > group C. However, the change trends in the three groups were slightly different. There was no statistical difference in other parameters related to accommodative function among groups.

3. Comparison of vergence function within groups: There were significant differences in NPC break value and recovery value, far NFV break point and far PFV break point in group A before and after operation (P <0.05). The NPC break value and recovery value increased after operation. The far NFV break point and far PFV break point decreased after operation, and the two indexes gradually approached the normal value after operation. There were significant differences in NPC break value and recovery value, far PFV break point, near NFV blur point and break point, near PFV blur point 、break point and recovery point in group B before and after operation (P <0.05). The NPC break value and recovery value increased after operation. The far PFV break point, near NFV blur point and break point, near PFV blur point、break point and recovery point decreased after operation, and these indexes gradually approached the normal value after operation. There were significant differences in NPC recovery value, far PFV blur point and break point , near NFV break point , near PFV break point in group C before and after operation (P <0.05). The NPC recovery value increased after operation. The far PFV blur point and break point , near NFV break point and near PFV break point decreased after operation, and these indexes gradually approached the normal value 3 months after operation.

4. Comparison of vergence function among groups: There were no significant differences in all of vergence function parameters (AC/A, NPC, NFV/PFV blur point, break point and recovery point) among the three groups.

5. There were no significant statistical differences in intra-group and inter-group differences in visual fatigue scores before and after SMILE surgery. However, the change trends of the three groups were basically the same, that was, the average

visual fatigue scores increased 1 week after operation, then decreased, and was lower than the preoperative level 3 months after operation.

Conclusions:

1. After SMILE surgery, myopic patients of different ages not noly had lower dioper and better vision, but also had better accommodative function, especially in the younger group.

2. After SMILE surgery, the vergence function of myopia patients of different age groups improved to different degrees, but there was no statistical difference among the three groups, indicating that age may have little effect on the vergence function before and after operation.

3. After SMILE surgery, the scores of visual fatigue increased 1 week after operation, then decreased, and were lower than the preoperative level 3 months after operation. Although there were no significant statistical differences within and among groups, it may still indicate that SMILE can improve the visual fatigue symptom in the long term.

Keywords:

age, SMILE, accommodation, vergence, binocular visual function

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中英文缩略词表

英文缩写	英文全称	中文全称
SMILE	small incision lenticule extraction	飞秒激光小切口角膜基质透镜取出术
UDVA	uncorrected distance visual acuity	裸眼远视力
BDVA	best corrected distance visual acuity	最佳矫正远视力
IOP	intraocular pressure	眼压
MPMVA	maximum plus to maximum visual acuity	最佳矫正视力
DLP	distance lateral phoria	远水平隐斜量
NLP	near lateral phoria	近水平隐斜量
AMP	amplitude of accommodation	双眼调节幅度
BCC	binocular cross-cylinder	调节反应
NRA	negative relative accommodation	负相对调节
PRA	positive relative accommodation	正相对调节
BAF	binocular accommodative facility	双眼调节灵敏度
AC/A	accommodation convergence/accommation	调节性集合/调节比值
NPC	near point of convergence	集合近点
NFV	negative fusional vergence	负融像性聚散
PFV	positive fusional vergence	正融像性聚散
BI	base in	底朝内
BO	base out	底朝外
D	diopter	屈光度
SE	spherical equivalent	等效球镜度
OD	oculus dexter	右眼
OS	oculus sinister	左眼

第 1 章　绪论

1.1　研究背景

随着科技的进步和教育事业的发展，电子产品的使用逐渐增加，户外活动的时间也越来越少，近视发病率持续上升，近视程度也逐渐加深[1]。据调查结果显示，预计到 2050 年全球将有接近一半的人患有近视，并且在中国儿童青少年中有明显的低龄化趋势[2]。同时，近视度数的增加必将导致视网膜脱离、白内障、青光眼、视网膜新生血管等近视相关并发症的发生，造成不可逆的视力丧失，为防盲治盲领域带来巨大挑战[3-5]。近视已经不仅仅是医学问题，更是备受关注的社会问题。近视带来的不便大大降低了生活质量，及早干预防止近视的发生发展，减少相关并发症的发生是近年来近视防控的重点[6]。常见的近视矫正方法包括戴镜矫正和手术矫正。戴镜矫正包括框架眼镜、角膜接触镜等；手术矫正包括角膜屈光手术、人工晶体植入手术（ implantable contact lenses ，ICL）及巩膜屈光手术等方式。由于戴镜的诸多不便以及手术技术的不断成熟，越来越多的成年患者选择以屈光手术的方式来获得满意的视力。尤其是近年来，飞秒激光小切口角膜基质透镜取出术 (small incision lenticule extraction surgery ,SMILE) 以其“微创”、“无瓣”、“创口小”、安全性及有效性高、生物力学稳定等独特优势成为角膜屈光手术方式的首选[7-10]。

在手术矫治为患者带来满意视力的同时，术后良好的视觉质量和主观视觉感受也日益受到重视[11]。研究发现，部分患者角膜屈光术后会出现视物模糊、视力下降、视物不能持久以及近距离工作困难等视疲劳症状，然而却没有明显的术后并发症和眼部器质性改变，这可能是由双眼视觉的功能性异常引起的[12-15]。双眼视功能是视觉中枢将双眼视觉信号分析整合成一个清晰图像的能力，主要包括调节功能和聚散功能，也是评价视觉质量的重要指标[16]。近年来，尽管一些学者对角膜屈光手术相关的双眼视功能变化进行了研究，但临床上仍有许多医生未能认识到其重要性，导致患者的视觉质量受到影响，甚至出现焦虑、抑郁等情绪，严重降低患者的生活质量[17-19]。因此关注角膜屈光手术前后患者的双眼视功能状况十分重要[11]。尤其是近年来随着角膜屈光技术的日益成熟，选择接受手术的患者中年龄偏大者也越来越多见。这部分人群在角膜屈光手术

围手术期需要进行更为严格的术前筛查，在手术设计时应全面评估双眼视功能情况，使患者术后视物能够清晰、舒适、持久，提高生活质量，避免影响患者的满意度[11,20-22]。既往相关研究多集中在 18~35 岁人群，本研究纳入了更大年龄范围的患者，对不同年龄段近视患者手术前后双眼视功能的变化及视疲劳状况进行讨论和分析，希望对日后手术设计及术后指导视功能训练、减少术后双眼视觉异常的发生提供一定的参考意义。

1.2　综述角膜屈光手术对近视患者双眼视功能的影响

1.2.1　概述

近年来全球近视和高度近视的人群越来越多，预计到 2050 年患病率将达到 49.8%和 9.8%[23]。近视逐渐成为世界上重要的公共卫生问题之一[3,6]。虽然其确切病因尚不清楚，但大量流行病学调查结果显示，近视是多因素共同作用的结果[24-27]。除了基因及种族等遗传因素外，自然环境因素、教育因素、生活习惯等因素也起了不可忽视的作用[6,28-29]。近视尤其是高度近视会增加眼部病理变化的发生风险，从而造成不可逆转的视力障碍或失明[3-5]。因此，必须及早预防近视的发生并采取合适的措施防止其进行性发展，同时减少其相关并发症的发生。目前近视防治的方法包括非手术方式和手术方式。非手术方式包括戴镜矫正和药物治疗如低浓度阿托品等。手术主要方式包括角膜屈光手术和人工晶体植入手术等。近年来，随着角膜屈光手术技术的不断成熟以及手术设备的不断更新，其安全性和有效性以及生物力学的稳定性越来越得到证实，SMILE、FS-LASIK、LASEK 等手术方式成为越来越多近视患者的选择[30-31]。很多近视患者术前都存在不同程度和类型双眼视功能的异常，角膜屈光术后早期双眼视觉异常问题也非常常见，可能引起视物模糊、视力下降、视力恢复慢、近距离工作困难、视疲劳等症状，严重影响患者的身心健康，加强双眼视功能是屈光手术亟待解决的问题，但临床上眼科医生对此的认识和重视程度却不够[12]。因此，下面就角膜屈光手术后近视患者双眼视功能的变化做一综述，希望对未来双眼视功能领域的相关研究提供一定的参考。

1.2.2　角膜屈光手术对近视患者双眼视功能的影响

1.2.2.1 调节功能

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