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Effect of microkeratome suction duration on corneal flap thickness and diameter in pigs

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Abstract

• AIM: To determine the effect of suction duration on thickness and diameter of corneal flap created by microkeratome in porcine eyes in laser *in situ* keratomileusis (LASIK).

• METHODS: Sixty porcine eyes were randomly assigned to three groups according to different suction durations: group 1 (10 seconds), group 2 (20 seconds), and group 3 (30 seconds). A Moria M2 microkeratome (Moria, France) with a 160μm head was used to create a corneal flap. Corneal flap thickness was measured by automated ultrasonic pachymetry, and the flap diameter was measured by a vernier caliper.

• RESULTS: The flap thickness of group 1, group 2 and group 3 was 146.05±13.46μm, 157.35±18.95μm and 169.25±21.02μm, respectively. There was a statistically significant difference among three groups (P=0.001). The mean flap diameter in groups 1, 2 and 3 was 8.63±0.19mm, 8.89±0.24mm and 9.06±0.18mm, respectively. A statistically significant difference was found among groups (P<0.01).

• CONCLUSION: In LASIK in porcine eyes, an increase in suction duration resulted in a thicker and greater flap.

• KEYWORDS: suction duration; lamellar corneal flap thickness; LASIK
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INTRODUCTION

Since its introduction in 1990[1], laser *in situ* keratomileusis (LASIK) has become currently the most frequently used surgical treatment to correct refractive errors worldwide[2,3]. LASIK involves a primary procedure of creating a corneal flap by microkeratome. The flap thickness based on the distance between the fixed microkeratome plate and the edge of the metal blade[4]. Some studies found variables that affect LASIK flap thickness include corneal curvature, corneal thickness, the amount of vacuum obtained during the procedure, microkeratome blade translation and oscillation rates, and blade reuse[5-10]. Our study explored the effects of different suction durations on flap thickness in LASIK.

MATERIALS AND METHODS

Materials Porcine eyes were obtained from a local abattoir. The eyes were kept at 4℃ in moist chambers and used for experiments within 12 hours of enucleation. The status of the epithelium in each eye was checked, and eyes with epithelial defects were excluded to avoid any bias in corneal thickness and incision angle measurements. Porcine eyes were randomly assigned to three groups, which were exposed to different suction durations: group 1 (10 seconds, 20 eyes), group 2 (20 seconds, 20 eyes), and group 3 (30 seconds, 20 eyes).

Methods

Preoperative examinations The intraocular pressure (IOP) of porcine eyes was controlled by the injection of normal saline through the optic nerve and maintained within 20mmHg to 25mmHg. IOP was measured with CT-60 non-contact tonometer (TOPCON, Japan). The IOP of each porcine eye was measured three times and then averaged.

Measurements of central corneal thickness (CCT) and keratometry were performed using Micropach 200 automated ultrasonic pachymeter (Sonomed, Japan) and RK-3 automatic keratometer (Canon, Japan). The CCT and keratometry of each porcine eye were measured three times and then averaged.

Microkeratome and surgical techniques A Moria M2 microkeratome (Moria, France) with a 160μm head was used to create a corneal flap. The Size -1 suction ring was chosen according to the manufacturer's instructions. The porcine eyes were placed on a stand with sufficient support for the surgical procedure. The same surgeon performed all procedures. A drop of normal saline was used to moisten and lubricate the cornea to facilitate the flap resection. The incision using the microkeratome was made from the midpoint of the temporal and inferior side to the nasal side (superior hinge) after the vacuum pressure of the Moria 2 control unit reached 108mmHg. Using different suction durations, the corneal flaps were made with microkeratome. The suction ring was removed and the corneal flap was retracted, exposing the underlying corneal stroma.

Table 1 Comparison of mean CCT, keratometery, flap thickness and diameter according to suction durations

	Group 1 (10s)	Group 2 (20s)	Group 3 (30s)	${}^aF$	${}^aP$
CCT (μm)	810.35±46.00	812.25±64.41	807.75±51.09	0.035	0.966
Keratometry (D)	40.34±1.93	40.43±1.49	40.31±1.51	0.032	0.969
Flap thickness (μm)	146.05±13.46	157.35±18.95	169.25±21.02	8.221	0.001
Flap diameter (mm)	8.63±0.19	8.89±0.24	9.06±0.18	22.610	<0.001

[a]Comparison among three groups

Measurement of Flap Thickness and Diameter After resection, the remaining corneal stromal thickness was measured centrally three times by the automated pachymeter. The difference in the corneal thickness and the remaining stromal thickness was defined as the flap thickness[11,12]. The diameter of the flap were measured three times using vernier caliper (Fushun measurement equipment factory, China).

Statistical Analysis One-way analysis of variance and Tukey's multiple comparison tests were used to evaluate the differences after various suction durations. $P \leqslant 0.05$ was considered statistically significant.

RESULTS

Preoperative CCT and Keratometry There were no differences in corneal thickness and keratometric values among the three groups (CCT: $F=0.035$, $P=0.996$; keratometry: $F=0.032$, $P=0.969$; Table 1).

Flap Thickness Values for the flap thickness varied with the suction duration. The thickness of group 1, group 2 and group 3 was 146.05 ± 13.46μm (10 seconds), 157.35 ± 18.95μm (20 seconds), and 169.25 ± 21.02μm (30 seconds) respectively. There was a statistically significant difference among 3 groups ($P=0.001$, Table 1). The flaps of group 1 (10 seconds) were statistically thinner than those of group 3 (30 seconds, $P<0.01$). However, there was no statistical significance between neither groups 1 and 2 ($P=0.128$), nor group 2 and 3 ($P=0.103$).

Flap Diameter The flap diameter increased along with suction duration (Table 1). The flaps of group 1 (10 seconds) were statistically larger than those of group 2 (20 seconds, $P<0.01$) and group 3 (30 seconds, $P<0.01$). Moreover, there was also statistical significance between groups 2 and 3 ($P=0.028$).

DISCUSSION

Although LASIK is safe, there are some complications, including iatrogenic keratectasia[3,13], which is the most serious late complication following LASIK. Altered biomechanics of the cornea following LASIK predispose it to ectasia despite normal IOP. The strength of cornea following LASIK is determined by the residual stromal bed thickness. If the corneal flap is unexpectedly thicker than intended, inadequate residual stromal thickness may occur, and then keratectasia may occur. Furthermore, variability in flap thickness can also have a direct effect on refractive correction because the depth of keratectomy relates to the amount of intraoperative bioelastic corneal change, which in turn affects the accuracy of the desired curvature change[14,15]. Therefore, the desired thickness of an ideal corneal flap should be consistent, predictable and accurate.

LASIK microkeratomes are designed to cut a predetermined flap thickness based on the distance between the fixed microkeratome plate and the edge of the metal blade[4]. Other variables that affect LASIK flap thickness include corneal curvature, corneal thickness, the amount of vacuum obtained during the procedure, microkeratome blade translation and oscillation rates, and blade reuse[5-10]. Because the eyeball is bioelastic, continuous suction delivered by a suction ring can change the shape of the cornea, causing it to bulge above the cutting plane, resulting in inconsistent flap thickness. Therefore, we focused only on the effect of suction duration on flap thickness and tried to control the other factors as precisely as possible in our study.

According to our data, values for the flap thickness varied with the suction duration. There was a statistically significant difference among 3 groups ($P=0.001$). The flaps of group 1 (10 seconds) were statistically thinner than those of group 3 (30 seconds, $P<0.01$). Therefore, in order to minimize the risk of cutting an overly thick flap and maintain a residual stromal bed thicker, maintaining optimal suction duration is necessary, which depends on practiced, perfect and smooth operation.

A thinner corneal flap is of benefit in the prevention of keratectasia. Control of flap thickness can be useful in the other clinical aspects. Very flat corneas with average keratometric power of less than 41 diopters (D) are at a greater risk for cutting a free flap[16]. A smaller area of the cornea is usually exposed to the microkeratome blade in these cases, resulting in a free cap[17]. Sufficient suction duration that thickens the flap would increase the hinge area and decrease the probability of creating a free flap.

In conclusion, values for the flap thickness and flap diameter varied with the suction duration. We suggest corneal flap thickness should be routinely measured intraoperatively to ensure that enough tissue remain after surgery.

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LASIK 术中负压吸引时间对猪角膜瓣厚度和直径的影响

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摘要

目的:探讨准分子激光原位角膜磨镶术(LASIK)术中负压吸引时间对角膜瓣厚度和直径的影响。

方法:根据负压吸引时间的不同将60只猪眼随机分为3组:组1(10s)、组2(20s)和组3(30s),使用法国产Moria M2型角膜板层刀分别吸引角膜10s,20s和30s后切削角膜瓣,利用角膜超声测厚仪测量角膜瓣厚度,应用镀铬游标卡尺测量角膜瓣直径。

结果:组1、2和3角膜瓣厚度分别为146.05±13.46,157.35±18.95和169.25±21.02μm,各组间比较有显著性差异($P=0.001$)。各组的平均角膜瓣直径分别为8.63±0.19mm(组1,10s),8.89±0.24mm(组2,20s)和9.06±0.18mm(组3,30s)。各组间比较有显著性差异($P<0.01$)。

结论:LASIK术中随着负压吸引时间的延长,角膜瓣厚度和直径均增加。

关键词:负压吸引;角膜瓣厚度;LASIK