Laser in situ keratomileusis (LASIK) has become a popular refractive surgery for patients with refractive error in recent years. After flap making using a microkeratome, it ablates the partial corneal stromal bed by excimer laser to correct refractive error. There is growing evidence that keratoectasia after LASIK may result from large variation in flap thickness (FT) [1]. Most surgeons do not routinely measure the actual thickness of the corneal flap or the residual stromal bed and treatment decisions are based on the FT announced by the microkeratome manufacturer. In fact, the real FT is variable after flap making [2–8]. To evaluate the variation in FT during the LASIK procedure, we measured the residual stromal bed by ultrasonic pachymeter after flap making with a microkeratome and calculated the actual corneal FT. We also analyzed the correlation between FT and central corneal thickness (CCT), FT and patient age, and FT and keratometric power.

**Key Words:** corneal flap thickness, corneal thickness, keratomileusis

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**Materials and Methods**

Sixty-two patients, 42 females and 20 males, with myopia or myopic astigmatism between March and August 2004 were enrolled. Baseline ophthalmic evaluation of the patients with myopic or myopic astigmatism included anterior segment and anterior vitreous by slit-lamp biomicroscopy; posterior vitreous, disc, and macula by slit-lamp biomicroscopy with 90-D lens; peripheral retina by indirect ophthalmoscopy; intraocular pressure by non-contact tonometer (CT-80, Topcon, Tokyo, Japan); CCT by ultrasonic pachymeter (MICROPACH 200P+, Sonomed, Lake Success, NY, USA); and keratometric power by autokeratorefractometer (KR-8100, Topcon) and topography (CT 200, Dicon, San Diego, CA, USA).

Patients were excluded from the study if they were younger than 20 years, had a history of uveitis,
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glaucoma, ocular trauma, severe dry eye syndrome, collagen disease, and systemic disease, or drug allergy. The preoperative CCT was measured five times using an ultrasonic pachymeter before surgery, not intraoperatively, and the averaged data were noted. After flap making and lift, the stromal bed thickness was measured five times again at the center of the stromal bed using an ultrasonic pachymeter before laser ablation, and the averaged data were also noted. Corneal FT was calculated by subtracting the central corneal stromal thickness from the preoperative CCT. The corneal flaps were created using a MK-2000 (Nidek, Gamagori, Japan) 130 μm microkeratome and a 9 mm size suction ring. The same surgeon performed all of the procedures. The first and second eyes used the same blade for the same subject. Half of the patients were started with flap cutting of the right eye and the other half of the left eye. The FT of the first eye in all subjects was analyzed in this study. The analysis was carried out using a coefficient of variation (CV), which was defined as 100% × standard deviation/mean. Temperature was maintained between 20°C and 22°C, humidity was maintained between 45% and 55%, and barometric pressure was fixed between 65 and 70 mmHg to maintain a constant suction pressure. In this study, statistical analyses were performed by linear regression analysis using SPSS software (SPSS Inc., Chicago, IL, USA). Statistical significance was defined as \( p < 0.05 \).

RESULTS

There were 42 females and 20 males with a mean age of 27.6 ± 4.9 years; the mean age for females was 28.8 ± 5.1 and that for males was 27.5 ± 4.9. Mean CCT was 540.6 ± 30.3 μm (range, 495–598 μm). Mean keratometric power was 43.66 ± 1.32 D (range, 47.00–41.25 D). Among a total of 62 eyes, mean FT was 133.2 ± 15.4 μm (range, 114–162 μm). The CV of the FT was 11.6%. There was a positive correlation between CCT and FT (\( p = 0.001 \)) (Figure 1) and no correlation between keratometric power and FT (\( p = 0.656 \)) (Figure 2) or between age and FT (\( p = 0.623 \)) (Figure 3).

DISCUSSION

An ideal microkeratome should produce a corneal flap of the desired thickness consistently. Theoretically, the distance between the fixed microkeratome plate and the edge of the metal blade determines the thickness of the flap during the flap cut [2]. In fact, several other variables are important in determining FT, such as the quality and the entry angle of the blade, translation and oscillation rate, the consistency across the cornea, suction ring pressure setting and suction duration, the mechanism of the cut, room humidity, preoperative CCT, and corneal diameter [2–8].
In this study, CCT was measured before surgery, not intraoperatively, to reduce the risk of infection during the intraoperative stromal bed thickness measurement. Reviewing the literature where the same microkeratome as in this study was used, a similar FT was found to be achieved: 133.2 ± 15.4 μm. Naripthaphan and Vongthongsri reported a mean FT of 120.52 ± 16.49 μm (range, 84–162 μm) for an 8.5 mm suction ring and 122.06 ± 18.54 μm (range, 84–149 μm) for a 9.5 mm ring [5]. Arbelaez reported a mean FT of 122.46 ± 17.65 μm [7]. Several reports have confirmed a positive correlation between CCT and the cutting thickness, similar to our results. Flanagan and Binder showed, using the automated corneal shaper (ACS) or the Summit Krumech Barraquer microkeratome (SKBM), that an increase in FT was associated with thicker preoperative pachymetry for both instruments [9]. Similar results have been reported by Jackson et al and Thompson et al for the Amadeus microkeratome, Yi and Joo for the SCMD manual microkeratome, Choi et al for the Innovatome automatic microkeratome, and Gailitis and Lagzdins for the Hansatome microkeratome [6,10–13]. The reason for this may be that a thicker cornea is more compressible in the superficial corneal area than a thinner cornea [8].

Flanagan and Binder reported that a steeper keratometry reading was associated with thinner preoperative corneas. They also reported that a steeper cornea was associated with thinner flaps using the ACS microkeratome but with thicker flaps using the SKBM. Furthermore, they also reported that an increase in patient age was found to be associated with thinner flaps for both microkeratomes [9]. In this study, there was no correlation between keratometric power and FT or between age and FT.

Although the first and second eyes used the same blade for the same subject when using the microkeratome, only the FTs of the first eyes in all subjects were analyzed in this study to investigate the actual FT and the variation of the MK-2000 microkeratome for the first cut. Previous reports have shown that a thinner flap results from the second cut using the same blade, and the main reason for this may be due to the fact that the blade becomes duller after the first cut [3,8]. In this study, the FTs still showed variation in a similar way to previous reports and, therefore, it is recommended that LASIK surgeons inspect the actual FT when using a microkeratome. It is also suggested that there be routine measurement of the corneal stromal bed thickness intraoperatively to ensure that enough tissue remains after surgery.

REFERENCES


原位雷射角膜重塑術所形成之角膜皮瓣厚度

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本研究實際測量原位雷射角膜重塑術中以角膜皮瓣微切器所形成之實際角膜皮瓣厚度。本研究中 42 位女性及 20 位男性近視或合併散光患者，術中以 130 微米微切頭形成角膜皮瓣。以超音波測量實際角膜厚度，並分析角膜皮瓣厚度與中心角膜厚度、角膜弧度、年齡之關聯性。62 位患者平均年齡 27.6 ± 4.9 歲，平均角膜皮瓣厚度為 133.2 ± 15.4 微米，平均中心角膜厚度為 540.6 ± 30.3 微米，平均角膜弧度為 43.66 ± 1.32 屈光度。角膜皮瓣厚度與中心角膜厚度有顯著性正相關，與角膜弧度及年齡則無顯著性相關。使用角膜皮瓣微切器的雷射屈光手術術者宜檢視實際角膜皮瓣厚度以獲得更穩定的術後效果。

關鍵詞：角膜皮瓣厚度，角膜厚度，角膜重塑術

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