Demographic profile and clinical course of Fuchs endothelial corneal dystrophy in Mexican patients

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Abstract

Purpose To describe the demographic characteristics and clinical course of Fuchs endothelial corneal dystrophy (FECD) in a Mexican-mestizo population.

Methods A retrospective observational and longitudinal study was performed in consecutive patients with the clinical diagnosis of Fuchs endothelial corneal dystrophy seen at our institution. Initial and last follow-up best-corrected visual acuity, slit-lamp findings, and specular microscopy endothelial morphometric parameters were analyzed.

Results One hundred and two eyes belonging to 51 patients were included in the analysis. Median age at the time of diagnosis was 69 years (range, 25–87 years) with a female-to-male ratio of 3.3:1. Visual loss (40%) followed by glare (13.3%) and fluctuating matutine vision loss (13.3%) was the most common complaints at presentation. Regarding FECD staging, 65 (63.7%) were classified as stage-I FECD, 21 (20.6%) stage-II, and 15 (14.7%) as stage-III. A high percentage of eyes (44.1%) presented visual impairment (≤ 20/50) at presentation, and the presence of isolated corneal guttata was the most common stage of presentation (64%) at slit-lamp examination. While fifty-nine (57.8%) eyes did not require any medical or surgical management, 17 (16.7%) eyes were managed with hypertonic saline eyedrops alone or in combination with bandage contact lens, and 18 (17.6%) required corneal transplantation. Penetrating keratoplasty alone (8 eyes, 44.4%), or in combination with cataract extraction and intraocular lens implantation (3 eyes, 16.7%), was the most frequent surgical technique performed.

Conclusion Demographical characteristics of Fuchs dystrophy regarding age at presentation, gender distribution, and clinical stage at the time of diagnosis did not differ significantly from other international reports. Almost 20% of these patients will require keratoplasty during the disease, emphasizing the need for safer and more reproducible keratoplasty techniques.

Keywords Guttae · Corneal endothelium · Fuchs endothelial corneal dystrophy · Specular microscopy · Keratoplasty
Introduction

Fuchs endothelial corneal dystrophy (FECD) is a bilateral corneal endothelium disorder with a complex hereditary profile, involving numerous genes and chromosomal loci, which influence its early-onset or, more commonly, its late expression with aging. It is the most frequent primary endothelial dystrophy and the leading indication for corneal transplantation worldwide [1]. FECD is characterized by the progressive decline of corneal endothelial cell density (ECD) with extracellular matrix (ECM) deposition on Descemet’s membrane (DM) in the form of guttae [2]. When the number of functional endothelial cells becomes critically low, fluid permeates the corneal stroma leading to edema and decreased vision [3]. Persistent stromal edema results in subepithelial and epithelial bullae, which eventually migrate anteriorly and rupture through the corneal epithelium, causing episodes of sharp pain, tearing, and foreign body sensation [4]. Worsening of stromal edema results in keratocyte apoptosis and subepithelial fibrosis with severe vision impairment due to loss of corneal transparency [5].

Despite being a significant cause of visual loss in elderly patients and the first indication of corneal transplantation worldwide, calculating the prevalence of FECD is challenging. The reason for this is that patients present with non-progressing corneal guttae, and most patients have signs and symptoms that manifest late in life, requiring surgical intervention after the sixth or seventh decades [6].

The clinical and demographical descriptions of FECD patients are based mainly on the experience of analyses performed on Caucasian and Asian populations [7–13]. To date, there is no information regarding the epidemiological characteristics of FECD in Hispanics. We analyze the demographical characteristics, clinical findings, disease stage, clinical course, and visual outcomes from FECD in a Mexican-mestizo population in the present study. According to an extensive literature search, this is the largest case series of FECD reported in Latin America.

Methods

We conducted a retrospective, observational, and longitudinal case series study of FECD patients seen at the Cornea and External Disease Service of our institution between January 2002 and November 2020. The study was previously approved by the Ethics (License No. P000355-CCEDEFM-CEIC-CR002) and Research (License No. P000355-CCEDEFM-CI-CR002) Committees of our institution (License No. CONBIOETICA 19 CEI 011–2016-10-17 and COFEPRIS 20 CI 19 039 002, respectively), following the tenets of the Declaration of Helsinki.

The inclusion criteria consisted of patients ≥ 18 years of age complaining of fluctuating vision (usually worse in the morning or under high relative humidity and improving during the day or under dry conditions). Also, patients visiting for a regular ophthalmic check-up showing slit-lamp changes compatible with FECD, and those revealed after a routine specular microscopy (SM) exam or Scheimpflug tomography analysis for refractive or anterior segment surgical planning. The exclusion criteria comprised patients with guttae without edema, Hassall–Henle bodies, and scattered pseudo-guttae, particularly in the peripheral zone. Patients not willing to participate, those with an incomplete medical record, or without an SM or Scheimpflug tomography analysis were also excluded from the study.

All patients included in this study were diagnose and classified according to Adamis’ staging system (Fig. 1) [2, 5]. The classification of the FECD stage was based on clinical features (Fig. 2). The main characteristic distinguishing corneal guttae from FECD is corneal edema developing in Fuchs dystrophy [14]. However, during FECD stage I, it is most challenging to make such a distinction. The following clinical features were contemplated for the diagnostic consideration of FECD: (1) subclinical edema detected as a subtle thickening difference between the central and paracentral cornea to the periphery seen on the slit-lamp examination or by Scheimpflug pachymetry, through the variation in the central-to-peripheral corneal thickness ratio, displacement of the thinnest point of the cornea, focal posterior corneal surface depression, or increased central corneal thickness (CCT); (2) scattered guttae becoming confluent to the central cornea, decreased ECD, and increased pleomorphism and polymegathism, analyzed by SM; and (3) subtle central anterior haze and stromal lines on the slit-lamp exam [5, 14, 15].

Relevant clinical information was retrieved from the medical records, including demographics, stage of
FECD, best-corrected visual acuity (BCVA), main complaint at presentation, slit-lamp biomicroscopic evaluation, lens status, posterior segment evaluation, including the retina and optic nerve, and medical and/or surgical management. Cataract was graded according to the Lens Opacities Classification System III (LOCS III) [16]. Automated SM (Tomey EM-3000, Nagoya, Japan) consisting of one central and six peripheral measurements at 2, 4, 6, 8, 10, 12 o’clock positions on a ø 6 mm arc (photographing range of 0.25 × 0.53 mm) was performed to obtain the corneal endothelium morphometric analysis in all cases. Data retrieved included endothelial cell density [ECD, average number of corneal endothelial cells (CEC) per mm²], pleomorphism (percentage of hexagonal cell), polymegathism (CEC size variations), or the coefficient of variation (variation in cell area), and CCT. Initial and final BCVA were classified into three groups according to the Standardization for Uveitis Nomenclature for Reporting Clinical Data (SUN): (1)
good, presenting BCVA better than 6/15 (Snellen > 20/50); (2) intermediate, presenting BCVA 6/15 or worse (Snellen ≤ 20/50); and (3) poor, presenting BCVA 6/60 or worse (Snellen ≤ 20/200) [17]. After excluding for patients with cataract, pseudophakia, aphakia, macular pathology (age-related macular degeneration, choroidal neovascularization, macular edema, vitreoretinal traction, epiretinal membrane formation, and atrophy), diabetic retinopathy, and glaucoma, we performed a sub-analysis to assess the main complaints at presentation and BCVA. For FECD staging, we only excluded patients with prior intraocular surgery.

At last consultation, follow-up time, BCVA, lens status, medical, and/or surgical management required to control the disease, and disease progression according to the Adamis et al.’s staging system were recorded [2, 5]. In patients with specular microscopy available at the last follow-up visit, the ECD loss was analyzed. The initial and final BCVA was measured with the Snellen visual acuity chart under standardized conditions and converted into the LogMAR scale for statistical purposes.

Statistical analyses were performed using IBM SPSS v.24 (IBM Inc., Armonk, NY, USA). Frequencies and percentages were used to describe categorical variables. Normality was evaluated with the Shapiro–Wilk test. Normally distributed variables were described with means and standard deviations (SDs), while non-normally distributed variables were described with medians and interquartile ranges (IQR).

## Results

### Sociodemographic characteristics

Fifty-one Mexican-mestizo patients (102 eyes) with a clinical diagnosis of FECD were included in the study. A total of 39 (76.5%) were women and 12 (23.5%) men, with a female-to-male ratio of 3.3:1 and aged between 25 and 87 years (median 69, IQR = 16.75). The sociodemographic characteristics of the study population are shown in Table 1.

| Characteristics                        | n (%)     |
|----------------------------------------|-----------|
| Gender                                 |           |
| Female                                 | 39 (76.5) |
| Male                                   | 12 (23.5) |
| Age*                                   |           |
| Female                                 | 69 (22–83) |
| Male                                   | 69.5 (25–87) |
| Systemic disease                       |           |
| None                                   | 32 (62.8) |
| Diabetes mellitus                      | 6 (11.8)  |
| Hypertension                           | 4 (7.8)   |
| Diabetes mellitus and hypertension     | 3 (5.9)   |
| Hypothyroidism                         | 3 (5.9)   |
| Rheumatoid arthritis                   | 2 (3.9)   |
| Systemic lupus erythematosus           | 1 (2.0)   |
| History of ocular disease (102 eyes)   |           |
| None                                   | 86 (84.3) |
| Glaucoma                               | 6 (5.9)   |
| Diabetic retinopathy                   | 8 (7.8)   |
| Age-related macular degeneration       | 2 (2.0)   |
| History of ocular surgery (102 eyes)   |           |
| None                                   | 68 (66.7) |
| Phacoemulsification                    | 25 (24.5) |
| Vitrectomy and phacoemulsification     | 2 (2.0)   |
| Refractive surgery                     | 6 (5.9)   |
| Penetrating keratoplasty               | 1 (1.0)   |

*Median (range)

### Clinical characteristics

A total of 32 (62.8%) patients were otherwise healthy at the first visit. Also, 86 (84.3%) eyes had no prior history of ocular disease; however, eight (7.8%) eyes had a confirmed diagnosis of diabetic retinopathy, six (5.9%) had glaucoma, and two (2.0%) eyes, age-related macular degeneration. Sixty-eight (66.7%) eyes had no previous history of ocular surgery. Phacoemulsification surgery with 25 (24.5%) eyes (Fig. 3), followed by refractive surgery with 6 eyes (5.9%) were the prevailing ocular procedures reported at first visit.

Table 2 outlines the clinical characteristics of all eyes (n = 102) included for analysis at the first visit.

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According to the SUN classification, 57 (55.9%) eyes had no visual impairment, 22 (21.6%) eyes had intermediate visual acuity, and 23 (22.5%) had poor visual acuity. The overall mean BCVA was $0.59 \pm 0.76$. While thirty (29.4%) eyes had a clear lens and healthy optic nerve and retina at the initial examination, 72 (70.6%) eyes had either cataract, optic nerve, and/or retinal abnormalities. Regarding corneal findings, 65 (63.7%) were classified as stage-I FECD, 21 (20.6%) stage-II, and 15 (14.7%) as stage-III FECD according to the Adamis and coworkers classification [5]. One eye had a prior history of penetrating keratoplasty (PKP). Eighty-seven (85.3%) eyes had specular microscopy performed at the diagnosis. After excluding eyes with prior ocular surgery (i.e., refractive surgery, cataract surgery, PKP, and vitrectomy), the corneal morphometrical analysis, age, and the clinical FECD stage at presentation of the remaining 68 eyes (Fig. 4) are shown in Table 3.

Visual analysis of eyes without other visual comorbidities

We included eyes ($n = 30$) with a clear lens, and without glaucoma and/or retinal pathology for visual analysis. Visual loss (40%) followed by glare (13.3%) and fluctuating matutine vision loss (13.3%) was the most frequent chief complaints. Six eyes (20%) were asymptomatic at initial visit. While twenty-six eyes (86.7%) had good visual acuity, four eyes (13.3%) had intermediate visual acuity. None of the eyes had poor visual acuity (Table 4).

Treatment

Fifty-nine (57.8%) eyes did not require any medical or surgical management. Seventeen (16.7%) eyes received medical management with hypertonic saline eyedrops alone (15 eyes) or in combination with a bandage contact lens (BCL, 2 eyes). On the other hand, 18 (17.6%) eyes required corneal transplantation. Of those, eight (44.4%) eyes were managed with PKP, three (16.7%) with a triple procedure (PKP + cataract extraction and intraocular lens implantation), two (11.1%) eyes with Descemet membrane endothelial keratoplasty (DMEK), and five (27.8%) eyes are currently waiting for a corneal donor. Of the remaining eight eyes (7.8%), six eyes (75%) were managed with cataract extraction and intraocular lens implantation, in one eye (12.5%) a vitrectomy was performed for the management of proliferative diabetic retinopathy, and one eye (12.5%) had a previous PKP.

Corneal outcomes

Complications arising from any form of corneal transplantation were present in 38.9% of the eyes, including four eyes with allographic rejection, two eyes with ocular hypertension (OHT), and one eye with FECD recurrence.
After a median follow-up of 60 months (range: 24–180; IQR 78), we could retrieve specular microscopy data in a subgroup of 26 (25.49%) of the eyes. Table 5 shows the disease stage and age at the last visit and the comparative corneal morphometric analysis of eyes at initial and final visits.

### Discussion

The demographic profile, corneal morphometric characteristics, clinical course, and therapeutic outcome of Latin-American patients with FECD have not been previously described. We analyzed 102 eyes from 51 Mexican-mestizo patients with FECD. Females predominated males by three to one, comparable to other Caucasian series showing a similar female predominance [4, 7, 8]. However, in a study performed in the USA, Rosenblum et al. reported a much larger female predominance (7.3:1) [18]. Another Caucasian study of 32 patients from Tangier found a female-to-male ratio of 2.6:1 [9], while data from Asians on predominantly corneal guttae stage I of FECD reported a ratio of 2.8:1 [11]. On the other hand, Lorenzzetti et al. found no significant differences in the incidence of corneal guttae between Caucasians and African-Americans [8].

Regarding the development of advanced FECD, female sex and age are the most significant risk factors for severe FECD requiring corneal transplantation [4, 19, 20]. Afshari et al. and Chan et al. reported a female prevalence of 77.6% and 61.8%, respectively, in FECD patient candidates for corneal transplantation [4, 19]. Contrary to these reports, only 17 eyes (16.67%) required corneal transplantation in our study. Of those, 64.7% were female patients. The reason for this gender-based disparity remains elusive. However, a recent murine study found that ultraviolet-A (UVA) light triggers estrogen-metabolizing enzymes and forms reactive estrogen metabolites and estrogen-DNA adducts in females but not male mice [21]. Moreover, UVA light also results in greater CEC loss and edema due to loss of tight-junction proteins (e.g., ZO-1) [22]. UVA exposure, however, might not fully explain the higher prevalence of FECD in women. In a study measuring the amount of ultraviolet radiation dose received by USA citizens, Godar et al. reported that males received higher doses [23]. Castanedo-Cazares et al. reported similar results in a Mexican-mestizo population [24]. The same author reported in another study that Mexicans disregard the potentially harmful effects of sun exposure, despite being aware of such effects [25]. Although UVA light damage seems a plausible explanation for the presence of FECD in our population, the gender-based disparity cannot be explained.

### Table 2 Clinical features of Fuchs endothelial corneal dystrophy obtained at initial consultation

| Characteristics                     | n (%)            |
|-------------------------------------|------------------|
| **Snellen BCVA**                    |                  |
| > 20/50                             | 57 (55.9)        |
| ≤ 20/50–> 20/200                    | 22 (21.6)        |
| ≤ 20/200                            | 23 (22.5)        |
| **Lens status**                     |                  |
| Clear                               | 33 (32.4)        |
| Cataract                            | 42 (41.2)        |
| Pseudophakia                        | 26 (25.5)        |
| Aphakia                             | 1 (1.0)          |
| **Optic nerve appearance**          |                  |
| Normal                              | 94 (92.2)        |
| Glaucomatous damage                 | 4 (3.9)          |
| **Retina & vitreous appearance**    |                  |
| Normal                              | 78 (76.5)        |
| Diabetic retinopathy                | 8 (7.8)          |
| Age-related macular degeneration    | 12 (11.8)        |
| Macular disease                     |                  |
| **Corneal findings [5]**            |                  |
| Stage I: Corneal guttae             | 65 (63.7)        |
| Stage II: Corneal edema             | 21 (20.6)        |
| Stage III: Bullous keratopathy      | 15 (14.7)        |
| Stage IV: Corneal scarring          | 0 (0)            |

FECD, Fuchs endothelial corneal dystrophy; BCVA, best-corrected visual acuity

*In four eyes (3.9%) fundus evaluation was not possible due to opaque media

^Age-related macular degeneration, edema, vitreomacular traction syndrome, atrophy

^Staging according to Adamis AP, Filatov V, Tripathi BJ, Tripathi RC (1993) Fuchs’ endothelial dystrophy of the cornea. Surv Ophthalmol 38:149–68. https://doi.org/10.1016/0039-6257(93)90099-s

One eye had previous history of penetrating keratoplasty
on this basis. More extensive studies are required to establish such a potential association.

Like previous studies, the average age of affected individuals was 65.35 years [11, 18]. Early-onset FECD, described as disease development before 40, occurred in only three (5.89%) of our patients. Such finding differs from other registries reporting a prevalence of up to 31.5% of FECD patients aged 10 to 39 [8]. So far, only the presence of the COL8A2 gene is associated with the early-onset form of FECD [26]. A variant presenting in the first decade of life has been described in patients with the COL8A2 gene mutations [27].

After excluding eyes with other potential causes of vision loss (i.e., cataract, pseudophakia, aphakia, macular pathology, diabetic retinopathy, and glaucoma), the mean baseline BCVA in our study was 0.14 LogMAR (20/28 Snellen eq.), which differs from other studies reporting better visual acuities (0.08 LogMAR, 20/24 Snellen eq.) in patients with FECD at diagnosis [28]. When evaluating eyes (n = 68) without prior intraocular surgery, 47 eyes (22.1%) were

### Table 3 Disease stage, age, and corneal morphometric analysis at presentation

| FECD stage | No. (%) | Age (yrs)* | ECD (mm²)* | CV (%)* | 6A (%)* | CCT (µm)* |
|------------|---------|------------|------------|---------|---------|-----------|
| I          | 47 (69.1) | 60.0 ± 17.7 | 1791.6 ± 622.5 | 50.5 ± 14.0 | 36.1 ± 10.5 | 520.5 ± 37.7 |
| II         | 15 (22.1) | 65.9 ± 6.8 | 1330.3 ± 726.7 | 45.8 ± 12.5 | 29.6 ± 10.4 | 561.5 ± 77.9 |
| III        | 6 (8.8) | 74.2 ± 7.3 | 914.4 ± 364.7 | 49.4 ± 23.5 | 32.4 ± 8.9 | 581.4 ± 38.3 |
| Total²     | 68 (100) | 62.5 ± 15.8 | 1609.2 ± 687.0 | 49.3 ± 14.4 | 34.3 ± 10.6 | 535.6 ± 53.3 |

ECD endothelial cell density; CV coefficient of variation/polymegathism; 6A hexagonality/pleomorphism; CCT central corneal thickness

*Mean ± standard deviation

²After excluding eyes with prior ocular surgery, including refractive surgery, cataract surgery, penetrating keratoplasty, and vitrectomy

![High magnification slit-lamp specular reflection image of a cornea with FECD showing prominent guttae. Specular microscopy of the same patient showing a CD = 1,106 cells/mm² with a high pleomorphism (only 18% hexagonal cells), and 66% polymegathism.](image)
classified as stage-1 FECD, 15 (22.1%) as stage-II, and six (8.8%) were classified as stage-III FECD (Table 3).

Although variable, a cutoff value \( C \geq 2,500 \) endothelial cells/mm\(^2\) has consistently been reported as normal [28–32]. In FECD patients, such values significantly decrease as the disease progresses. In a study performed in Asians, Kobashi et al. found a mean ECD of 1,893 cells/mm\(^2\) in patients with FECD [28]. In the present study, we report an even lower ECD (1,516.69 cells/mm\(^2\)). Such difference might be explained by ethnicity but also by a delayed diagnosis. Previous studies have shown significant differences in the corneal ECD among different racial and ethnic groups and ages [29, 31]. McGlumphy et al. reported that, compared with Caucasians, African-Americans and Asians had increased values of ECD, Hispanics had lower values [29]. A decrease in ECD occurred in our series with the increasing severity of FECD and age (Table 3). Corneal thickness represents an important parameter to measure disease progression and aid in surgical decision-making [33]. The mean CCT was 520.5 μm in stage-I, 561.5 μm in stage-II, and 581.4 μm in stage-III in our study population. Kopplin et al. evaluated the relationship between CCT and FECD severity [34]. They found that with the increasing severity of FECD, an increase in CCT occurred. Such findings were also observed in patients without clinically visible edema [34]. Moreover, a study of 259 eyes managed with PKP found that a preoperative corneal thickness of 775 μm or greater was a significant risk factor for a BCVA of 20/100 or worse, while below that level, BCVA was 20/60 [4].

Of note, a CCT \( \geq 640 \) μm renders the cornea an increased risk for endothelial decompensation and poor BCVA after cataract surgery. Thus, performing a triple procedure in patients above such a limit is recommended [33]. However, the absolute value of CCT must be interpreted with caution since normal corneas without edema may also have a CCT \( \geq 640 \).

### Table 4

| Characteristics           | n (%) |
|---------------------------|-------|
| **Chief complaint**       |       |
| No symptoms               | 6 (20.0) |
| Vision loss               | 12 (40.0) |
| Glare                     | 4 (13.3) |
| Fluctuating vision        | 4 (13.3) |
| Dry eye                   | 2 (6.7) |
| Floaters                  | 2 (6.7) |
| **Snellen BCVA**          |       |
| > 20/50                   | 26 (86.7) |
| \( \leq 20/50 –> 20/200 \) | 4 (13.3) |
| \( \leq 20/200 \)         | 0 (0) |

**FECD** Fuchs endothelial corneal dystrophy; **BCVA** best-corrected visual acuity

*After excluding for patients with cataract, pseudophakia, aphakia, macular pathology, diabetic retinopathy, and glaucoma



### Table 5

| FECD stage | n (%) | Age* | ECD (mm\(^2\))# | CV (%)# | 6A (%)# | CCT (μm)# |
|------------|-------|------|-----------------|---------|---------|-----------|
| I          | 10    | 68.8 ± 22.3 | 1220.7 ± 516.4 | 52.1 ± 8.2 | 30.5 ± 5.1 | 510.8 ± 58.0 |
| II         | 11    | 81.5 ± 9.8  | 1232.0 ± 710.6 | 54.6 ± 15.7 | 33.3 ± 8.8 | 571.7 ± 53.6 |
| III        | 2     | 77.5 ± 0.7  | 1191.5 ± 738.9 | 50.5 ± 7.7  | 34.5 ± 6.3  | 567.0 ± 46.6 |
| IV\(^a\)   | 3     | 76.3 ± 0.58 | 1083.3 ± 220.7 | 38.0 ± 18.1 | –        | 519.6 ± 31.5 |
| At presentation\(^y\) | 69.1 | 1319.1 | 50.0 | 31.6 | 545.4 |
| Last visit\(^y\)       | 75.5 ± 15.3 | 1201.85 ± 560.3 | 51.5 ± 13.13 | 32.2 ± 7.1 | 543.3 ± 57.5 |
| % change from baseline\(^y\) | + 8.48 | – 8.89 | + 2.91 | + 1.89 | – 0.39 |

*Mean ± standard deviation

\(^a\)The specular microscopy (Tomey EM-3000, Nagoya, Japan) was not able to obtain hexagonality values

**ECD**, endothelial cell density; **CV**, coefficient of variation/polymegathism; **6A**, hexagonality/pleomorphism; **CCT**, central corneal thickness

\(^y\)Values from the 26 eyes with specular microscopy at initial and final visit
μm [35]. Other recently described parameters, measured with Scheimpflug tomography, including loss of regular isopachs, displacement of the thinnest point, focal posterior surface depression, and anterior corneal backscatter, may represent better predictors for FECD progression after cataract surgery [36].

Seventeen percent of eyes required corneal transplantation. Only two out of seven eyes (28.6%) managed with PKP or triple procedure achieved a BCVA better than 20/200. However, the two eyes managed with DMEK achieved a final BCVA of 20/20 and 20/40. A recent study performed by Castellucci et al. compared the visual outcomes and quality of life after bilateral ultrathin Descemet's stripping automated endothelial keratoplasty (UT-DSAEK) with bilateral PKP for FECD [37]. Corneal high-order aberrations (HOAs), contrast sensitivity, BCVA, and quality of life were measured. After a mean follow-up of 32 months, all outcomes significantly favored UT-DSAEK. Only posterior HOAs were similar among groups. This study, however, was retrospective and included a small sample (13 in the UT-DSAEK group vs. 11 in the PKP group) [37]. Regarding graft clarity and ECD, Price et al. demonstrated that DSAEK and PKP were comparable after 3-years. Notwithstanding, a 3.2-mm DSAEK incision width was associated with significantly less ECD than a 5.0-mm incision [38].

The limitations to this study have to do with its retrospective nature, limiting the availability of standardized and complete clinical data and, a reasonable number of eyes analyzed had other ocular comorbidities that precluded an accurate analysis. Strengths include the fact that this is the first study evaluating the clinical profile of FECD patients in a Latin-American population.

**Conclusions**

The characteristics of Fuchs dystrophy in Mexican-mestizo patients, regarding gender distribution, age at presentation, and early detection, do not vary significantly from other international reports. Almost 20% of these patients will require keratoplasty during the clinical course of the disease. Therefore, appropriate surgical indication and timing are crucial to avoid late-stage complications, including mature cataract formation, prominent stromal edema, and scarring resulting in significant visual impairment affecting the patient’s quality of life. Furthermore, late surgical intervention conditions the patient to penetrating keratoplasty instead of a less invasive and much quicker visual rehabilitating procedure such as endothelial keratoplasty (DSAEK or DMEK). This study increases the awareness of the occurrence of FECD in Latin-American patients and contributes to improving our understanding of the clinical behavior of this visual disabling disease in this ethnic group.

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**Authors’ contributions** MBS contributed to study protocol preparation, Ethics and Research Committees submission and revision, patients’ assignment, data collection and analysis, manuscript writing and editing; ICHC contributed to study design, statistical analysis, manuscript writing, and revision; RERL contributed to data collection, manuscript writing and revision, tables, and figures editing; ARG contributed to original idea, project coordination, study design, funds raising, manuscript writing and editing. All authors read and approved the final manuscript.

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**Declarations**

**Conflict of interest** The authors declare no conflicts of interest nor financial disclosures.

**Data availability** Data of this study are available upon request from the corresponding author. The data are not publicly available because the study was approved under informed consent for research purposes, protecting the participants’ privacy, prohibiting sharing information with third parties according to the Mexican General Law for the Protection of Personal Data in Possession of Obligated Parties.

**Ethical approval** The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethics (Registration No. P000355-CCEDFM-CEIC-CR002) and Research (Registration No. P000355-CCEDFM-CICR002) Committees of our institution (License No. CONBIOETICA 19 CEI 011–2016–10–17 and COFEPRIS 20 CI 19 039 002, respectively).

**Informed consent statement** Informed consent by the patient was obtained to disclose health information and publish clinical images.
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