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Evaluation of corneas in patients with Bell's palsy using optical coherence tomography

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Abstract

Measurements of Central Corneal Thickness and Central Corneal Epithelial Thickness Using Anterior Segment Optical Coherence Tomography (OCT) to Identify Potential Changes in Patients with Facial Paralysis. Thirty patients diagnosed with unilateral idiopathic Facial Faralysis between 2020 and 2021 at the Ear, Nose, and Throat Clinic of Elazığ City Hospital were included in our study. There were eighteen male patients (60%) and twelve female patients (40%). The mean age of the patients was 38.03±7.05 years. Central corneal thickness and central corneal epithelial thickness measurements were performed on the affected and unaffected eyes of the patients using an optical coherence tomography device at the time of diagnosis and one month later. There was no statistically significant difference in central corneal thickness and central corneal epithelial thickness between the affected and control groups in measurements taken at the time of diagnosis and one month later ($p>0.05$). This study represents the first evaluation of corneal tissue, a highly potentially affected structure in Facial Paralysis, using optical coherence tomography in the literature.

Keywords: facial paralysis, optical coherence tomography, central corneal thickness, central corneal epithelial thickness

1. Introduction

The anatomy and function of the facial nerve (FN) were first described by Sir Charles Bell in the 1800s. The facial nerve (7th cranial nerve) is primarily a motor nerve responsible for innervating the muscles responsible for facial expression, some chewing muscles, as well as for controlling functions such as hearing, salivary and tear gland secretion, and taste sensation for two-thirds of the tongue.

Facial nerve paralysis is characterized by acute, unilateral, partial, or total paralysis of the face. The course of the disease and the affected functions may vary depending on which part of the facial nerve is involved.

There can be various causes of facial paralysis, including viral infections, traumas, tumors, and sometimes idiopathic factors with no identifiable cause. The most widely accepted etiology of facial paralysis is a viral inflammatory condition. While definitive proof of this theory may be lacking, accumulating evidence suggests that dormant Herpes virus species (Herpes simplex virus-1 and Herpes zoster virus) in cranial nerve ganglia may trigger this condition. Furthermore, the isolation of Herpes virus DNA using sensitive PCR methods from samples taken from the facial nerve during acute facial paralysis supports the viral inflammation theory. Reactivation of these viruses is considered a potential source of inflammation in the facial nerve(1).

The seventh cranial nerve is the most commonly affected nerve among cranial nerves in terms of functional disorders. The primary reason for this is the nerve's relatively longer course compared to others and its convoluted path within the narrow bony passage known as the Fallopian canal. Due to its anatomical characteristics, any damage or loss of function is more quickly noticeable (2). Idiopathic facial paralysis, also known as Bell's palsy, is the most frequently encountered type and typically presents with a sudden onset.

Bell's palsy is most commonly observed in individuals aged between 16 and 50, with an incidence rate ranging from 15 to 45 per 100,000. The male-to-female ratio is equal in this condition, but the risk increases approximately threefold, especially during the third trimester of pregnancy and the first week after childbirth. Additionally, factors such as diabetes, upper respiratory tract infections, tooth extraction, exposure to windy or air-conditioned environments have been reported by patients. During the initial examination, partial paralysis is

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present in 30% of patients, while 70% experience complete paralysis (3).

Mild pain, numbness, increased sensitivity to sound, and taste alterations may accompany it. It is most commonly observed between the ages of 15 and 40. In the majority of cases, it spontaneously resolves within one month; however, delayed recovery or incomplete healing may occur in 30% of cases (4).

In facial nerve paralysis, a decrease in innervation of the orbicularis oculi muscle due to the affected nerve leads to a reduction in eye protection. Incomplete closure of the eyelid and increased evaporation and reduced production of tears can predispose to corneal problems (5,6). The N. petrosus superficialis major, which operates in conjunction with the facial nerve, plays a significant role in tear secretion through parasympathetic signals. A decrease in tear secretion can be detected through the Schirmer test in a broad clinical spectrum associated with facial paralysis (7). Preserving the corneal tissue is of utmost importance in patients with facial paralysis. A comprehensive ophthalmological examination should be conducted, and necessary medical treatments should be initiated, followed by regular monitoring at intervals.

Optical Coherence Tomography (OCT) was initially used to visualize posterior segment structures, such as the retina and optic nerve head in detail. Over the years, it has evolved into a non-invasive, crucial diagnostic technique for ophthalmic diseases. However, recent technological advancements have transformed OCT into a critical tool not only for the posterior segment but also for the anterior segment of the eye. The anterior segment refers to the front portion of the eye, housing a range of important anatomical structures from the tear film to the lens. Conventional methods provide limited information about the tear film and the cornea. OCT is a highly reproducible non-invasive and non-contact method. It offers precise probe beam positioning in the center of the cornea due to monitor-based magnification. Consequently, OCT results are not influenced by probe misplacement. OCT, by providing three-dimensional and high-resolution images of these structures, establishes a foundation for more precise diagnoses and treatment plans.

The objective of this study is to identify early-stage changes in the cornea and corneal epithelium that may occur in the course of facial paralysis using OCT (Optical Coherence Tomography) methodology. This will enable the early detection of corneal pathologies that may arise due to the disease. Additionally, it can provide valuable data regarding the success of treatments administered to patients.

2. Materials and Methods

Thirty patients diagnosed with unilateral idiopathic facial paralysis between 2020 and 2021 at the Ear, Nose, and Throat Clinic of Elazığ City Hospital were enrolled in our study. All patients were examined and diagnosed by two Ear, Nose, and Throat specialists (N.S) working in the clinic. During the clinical evaluation at the Ear, Nose, and Throat Clinic, the medical history of each patient was carefully investigated. Subsequently, facial asymmetry, the function of facial muscles, and potential other symptoms were assessed. Electromyography (EMG) was employed to evaluate the degree of nerve damage in patients deemed necessary, and Magnetic Resonance Imaging (MRI) was used to rule out anatomical pathologies of the facial nerve. Furthermore, examination of the middle ear and tympanic membrane was conducted using Slit Lamp Microscopy, as these structures are related to the facial nerve. The function of the facial nerve was assessed using measurement tools such as the House-Brackmann score.

Patients were referred to the Ophthalmology Clinic for a comprehensive ophthalmological examination, which included assessments of visual acuity, intraocular pressure, slit-lamp biomicroscopic anterior segment examination, and fundus examination. Among the patients with facial paralysis, those with pathologies such as corneal haze and scarring, corneal dystrophies, and any ectatic conditions like keratoconus, as well as those with a history of corneal or intraocular surgery, were excluded from the study. During the general ophthalmological examination of this patient group, individuals with conditions such as glaucoma, uveitis, cataracts, a previous diagnosis of dry eye, and eyelid anomalies (ectropion and/or entropion) were also excluded from the study(8).

Central corneal thickness and central corneal epithelial thickness measurements were taken with an optical coherence tomography (OCT) device for both the affected and unaffected eyes of the patients at the time of diagnosis and one month later. Corneal OCT speckle statistics are dependent on intraocular pressure (IOP) (9). Therefore, to ensure there were no significant IOP differences between the two compared groups, tonometry measurements were conducted for all patients. The devices were pre-opened to stabilize their operating temperatures before measurements. All measurements were taken at the same time of day, between 10:00 AM and 12:00 PM, to minimize the daily variations in IOP and OCT speckle parameters.

This prospective study was conducted with the collaborative participation of the Ear, Nose, and Throat (ENT) and Ophthalmology departments. The study adhered to the principles of the Helsinki Declaration and was approved by the Ethics Committee of Firat University. All individuals received both verbal and written information regarding the study, and each subject provided written and informed consent before participating in the study.

Statistical Analysis

SPSS 26.0 (IBM, Chicago, IL, USA) software was used for statistical analysis. The Wilcoxon T test was employed for

pairwise comparisons. A p-value of less than 0.05 was considered statistically significant.

3. Results

Thirty patients diagnosed with facial paralysis were included in our study, with 18 (60%) being male and 12 (40%) female. The mean age of the patients was 38.03±7.05 years. The unaffected eyes of the patients served as the control group. The recovery period for facial paralysis was 36.6±7.04 days. In the initial measurements conducted with an optical coherence tomography (OCT) device at the time of diagnosis, central corneal thickness was 549.06±38.29 µ, and central corneal epithelial thickness was 52.1±3.15 µ on the affected side of patients with facial paralysis. In their other eyes, central corneal thickness at the time of diagnosis was 545.1±36.84 µ, and central corneal epithelial thickness was 53.26±3.61 µ. In the measurements repeated 30 days later, central corneal thickness on the affected side of patients with facial paralysis was 546±33.36 µ, and central corneal epithelial thickness was 52.96±3.56 µ. In the control group, central corneal thickness was 541.5±35.41 µ, and central corneal epithelial thickness was 53.06±3.17 µ. There was no statistically significant difference in both central corneal thickness and central corneal epithelial thickness between patients at the time of initial diagnosis and 30 days later ($p>0.05$, $p>0.05$). Furthermore, no statistically significant difference was observed in the comparison with the control group ($p>0.05$).

4. Discussion

In the evaluation of patients with facial paralysis, ophthalmologically, it is crucial to assess the risks to the cornea to ensure the preservation of healthy vision. Factors such as reduced or incomplete blinking, retracted upper or lower eyelids, and decreased tear production can lead to corneal tissue impairment. In a study conducted by Zhang et al., corneas of patients with facial paralysis were assessed using confocal microscopy. Morphologically, they observed a reduction in corneal subbasal nerve density and an increase in dendritic cells, indicative of inflammation, in the patients' corneas. They established correlations between corneal epithelial defects, corneal opacity, and corneal sensitivity with corneal subbasal nerve density and dendritic cell counts. Corneal epithelial lesions were detected in 83.3% of the patients in the study (10). Pathological changes in the cornea can develop as a consequence of both reduced tear production and changes in the eyelid, but they can also originate primarily from morphological alterations in the corneal structure.

In the initial ophthalmological examinations of 92 patients with facial paralysis, superficial punctate keratopathy was observed in 81.6% of the patients, while 4.4% had corneal scars, 3.3% had corneal ulcers, and 2.2% had corneal abrasions (11). This indicates that a high degree of corneal involvement can be observed in patients even in their initial examinations. In our study, we identified superficial corneal punctate epitheliopathy in 12 patients (40%) and corneal abrasion in 2 patients (6.6%). Following the initiation of topical treatments, the patients' symptoms improved, and no complications were observed. None of the patients in the study experienced facial paralysis lasting more than 45 days; all of them returned to normal nerve function within an average of 36.6±7.04 days. The low incidence of corneal complications in our study suggests the role of both the duration of facial paralysis and the early detection of lesions in the initial examinations and the initiation of early treatment. At the time of their initial referral, only 26.6% of the patients (8 patients) had symptoms related to corneal findings. This underscores the importance of referring all patients to ophthalmological examination immediately after a diagnosis of facial paralysis, regardless of the presence of corneal symptoms, for the prognosis of their vision.

Anterior segment optical coherence tomography (OCT) is an important diagnostic tool for assessing corneal thickness, the status of corneal layers after corneal surgery, anterior chamber depth, and lesions related to corneal diseases. It enables us to non-invasively detect detailed cross-sections of tissues. The first anterior segment OCT image was published in 1994 (12). Anterior segment OCT can easily detect pathologies such as corneal thickness, edema, ulcers, and scars (13). In patients with dry eye syndrome, corneal epithelial thickness profiles have been evaluated with OCT, and it has been found that thickness changes correlate with symptoms and are useful in monitoring treatment response (14,15). In our study, we measured the corneal epithelial thickness and corneal thickness of facial paralysis patients using anterior segment OCT after diagnosis. However, we did not detect any difference in corneal epithelial and corneal thickness between the initial diagnosis and the 1-month follow-up examinations. There was also no significant difference when compared to the control group. Direct nerve damage, inflammation, reduced tear production, and lid pathologies resulting from facial nerve paralysis are expected to cause changes in corneal tissue. Contrary to expectations, our study did not find any differences in epithelial thickness and total thickness despite secondary changes due to facial paralysis. The absence of any significant differences indicates that corneal OCT alone may not be sufficient for diagnosis and monitoring during the course of the disease.

The relatively young age of the patients and the average recovery time of facial paralysis within 1 month, as well as early initiation of treatment, are factors we believe influenced our results. The limitations of our study include the relatively small number of patients and the relatively short follow-up period, which did not extend beyond the early recovery phase.

Conflict of interest

The authors declared no conflict of interest.

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Ethical statement

Ethics committee approval was obtained by Fırat University Clinical Research Evaluation Committee with the decision number 2021/08-37 dated 24.06.2021. Because the study was designed retrospectively, no written informed consent form was obtained from patients. The study protocol complies with international agreements.

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None to declare.

Authors' contributions

Concept: M.K.K, S.A, F.C.G, S.K ,Design: M.K.K, S.K, Data Collection or Processing: S.K, N.S, F.C.G, Analysis or Interpretation: M.K.K, S.A, Literature Search: M.K.K, S.K, F.C.G, S.A, Writing: M.K.K, S.A, S.K.

References

1. Holland NJ, Weiner GM. Recent developments in Bell's palsy. Br Med J. 2004; 329:553–557.
2. Çelik O. Kulak Burun Boğaz Hastalıkları ve Baş Boyun Cerrahisi. İçinde: Cemil Mutlu Periferik Fasiyal Paralizi. Asya Tıp Kitabevi, İzmir 2007, s: 269-83.
3. Morris AM, Deeks SL, Hill MD, Midroni G, Goldstein WC, Mazzulli T, Davidson R, Squires SG, Marrie T, McGeer A, Low DE. Annualized incidence and spectrum of illness from an outbreak investigation of Bell's palsy. Neuroepidemiology. 2002; 21:255–261.
4. Holland NJ, Bernstein JM. Bell's palsy. BMJ Clin Evid. 2014 Apr 9;2014:1204. PMID: 24717284; PMCID: PMC3980711.
5. Fattah A, Borschel GH, Manktelow RT, BezuhlyM, Zuker RM. Facial palsy and reconstruction. Plastic Reconstr Surg. 2012;129:340e–52e.
6. MacIntosh PW, Fay AM. Update on the ophthalmic management of facial paralysis. Surv Ophthalmol. 2019 Jan-Feb;64(1):79-89. doi: 10.1016/j.survophthal.2018.06.001. Epub 2018 Jun 8. PMID: 29886125.
7. Bayındır T, Tan M, Selimoğlu E. Bell Paralizisinde tanı ve tedavi yöntemleri. Ell .J of Otl.&Hed Nec Surg. 2011;10(1)
8. Jesus DA, Iskander DR. Assessment of corneal properties based on statistical modeling of OCT speckle. Biomed Opt Express. 2017;8(1):162–176.
9. Niemczyk M, Danielewska ME, Kostyszak MA, Lewandowski D, Iskander DR. The effect of intraocular pressure elevation and related ocular biometry changes on corneal OCT speckle distribution in porcine eyes. PLoS One. 2021;16(3):e0249213.
10. Zhang J, Zhao Z, Shao C, Fu Y, Ding X, Cao Y, Zhu X, Wu X, Wang W, Fan X, Li J. Degeneration of Corneal Sensation and Innervation in Patients with Facial Paralysis: A Cross-Sectional Study Using in Vivo Confocal Microscopy. Curr Eye Res. 2019 Nov;44(11):1209-1215. doi: 10.1080/02713683.2019.1628280. Epub 2019 Jun 20. PMID: 31162988.
11. Joseph SS, Joseph AW, Smith JI, Niziol LM, Musch DC, Nelson CC. Evaluation of Patients with Facial Palsy and Ophthalmic Sequelae: A 23-Year Retrospective Review. Ophthalmic Epidemiol. 2017 Oct;24(5):341-345. doi: 10.1080/09286586.2017.1294186. Epub 2017 Mar 20. PMID: 28319442.
12. Izatt JA, Hee MR, Swanson EA, et al. Micrometer-scale resolution imaging of the anterior eye in vivo with optical coherence tomography. Arch Ophthalmol 1994;112:1584–1589
13. Maeda N. Optical coherence tomography for corneal diseases. Eye Contact Lens. 2010 Sep;36(5):254-9. doi: 10.1097/ICL.0b013e3181ef0dbb. PMID: 20724851.
14. Abou Shousha M, Wang J, Kontadakis G, Feuer W, Canto AP, Hoffmann R, Perez VL. Corneal epithelial thickness profile in dry-eye disease. Eye (Lond). 2020 May;34(5):915-922. doi: 10.1038/s41433-019-0592-y. Epub 2019 Oct 1. PMID: 31576026; PMCID: PMC7182579.
15. Stephen E. Morley. Are dynamic procedures superior to static in treating the paralytic eyelid in facial paralysis? 2023 Feb; 77:8-17.