Medical and Research Publications
International Open Access

Research Article Journal of MAR Ophthalmology (Volume 4 Issue 2)

Briefly about Cornea

Siniša Franjić *, Yujia Zhai[1]

1. Ophthalmologist, China.

Corresponding Author: Siniša Franjić, Independent Researcher

Received Date: April 22, 2022

Published Date: May 01, 2022

Abstract

The cornea is the transparent front of the eye that covers the iris, pupil and anterior chamber of the eye. Together with the lens, the cornea serves to refract light and as a result helps the eye to focus and is responsible for approximately two-thirds of the refractive power of the eye. In humans, the refractive power of the cornea is approximately 43 diopters. While the cornea is responsible for most of the power of the eye's focus, its focus is constant. The curvature of the lens, on the other hand, can be adjusted to achieve a satisfactory focus depending on the distance of the observed object.

Keywords: *Cornea, Eye, Injury, Corneal Power*

Introduction

The cornea acts as a transparent refractive surface and a protective barrier to infection and trauma [1]. Its anterior surface is elliptical (11.7mm horizontally, 10.6mm vertically), whereas its posterior surface is circular (11.7mm). It's thinnest centrally (around 535 microns) and thickest within the periphery (660 microns).

Unlike other ocular structures, likewise as most tissues within the body, the cornea does not show important changes with normal aging [2]. A variety of corneal aging changes have, however, been reported. Few of them are clinically evident, while others are demonstrated by chemical, biological, and structural studies. Distinction must be made between conditions considered within the traditional limits of aging and those of true disease processes that commonly affect the cornea within the elderly. The difference with other ocular structures is that changes of the cornea due to aging are mostly asymptomatic and do not usually affect vision, hence they are doing not require treatment. However, some changes occur and, as an example, the aged cornea becomes more susceptible to infection due to decreased ability to resist a spread of physiological stresses. Furthermore, it is sometimes difficult to distinguish age-specific deterioration from degenerations modified by environmental and genetic factors.

Anatomy

As we gaze into our own eyes in a mirror or into the eyes of another human being, we are aware of particular characteristic features [3]. The clear curve of the cornea, set into the white of the conjunctiva, the wrinkled surface of the colored iris behind the clear cornea, the protective lids, and their eyelashes sweeping over the world in periodic blinks. Handling an individual's eye removed from its bony orbit (something few of us, except for vision scientists, pathologists, and anatomists ever do), its toughness, and also the feel of the world as pliable but rigid due to fluid contained in its tough outer covering is very striking. the color of the iris and also the size of the clear cornea dominate its appearance when the eye is in place; removed, the cornea and also the iris behind it, with the opening (pupil) behind it, seem, within the isolated human eye, much too small for the scale of the world. Straggling off the rear, slightly off to at least one side (the nasal or side closest to the nose) is that the tough sheath surrounding the optic nerve, the eye's output line to the rest of the brain and carrier of the complex visual processing the cellular circuits of the retina achieves. The optic nerve also conducts the nutritive lines, arteries, and veins, which supply the metabolic demands of the eye. Not visible from the outside of the world (unless using optics to seem through the cornea and lens) is that the retina, where photoreception and also the initial stages of visual processing occur.

Another notable aspect of the outside of the isolated human eye is that of the ocular muscles, which have attachment points on the tough outer white of the eye (sclera). Their number and orientation are responsible for the coordinated motion of the globes within the bony eye-sockets of the skull.

Ocular movements are coordinated within the central nervous system (CNS) and interact with visual stimuli using intricate feedback from visual pathways.

The tough outer "white" of the eye could be a connective tissue layer known as the sclera. The pressure makes the sclera rigid enough to keep the optical length of the eye constant and support the movement of the eye under muscular control. The sclera's cellular makeup and molecule configuration change to create the cornea, the clarity of which equals that of inorganic glasses or crystals. This clarity of the cornea is because of a different size range, spacing, and orientation of the protein molecules (collagen) that make up the cornea as compared to the sclera. Corneal clarity is maintained by metabolic work of cell layers on the backside of the cornea (the corneal endothelial cell layer) and therefore the outer surface (the corneal epithelium).

These cell layers use cellular energy to maintain the ionic (and, hence, water) content of corneal tissue; this work prevents corneal swelling, maintains the spacing of collagen molecules and, thereby, keeps the tissue transparent. The corneal epithelium is densely innervated with nerve endings. This density of nerve endings is evident to us humans when "something is in my eye!" i.e. when debris gets onto the corneal surface. The refractive properties of the cornea account for a great percentage of the optical properties of the eye, much more than the lens. The importance of the cornea as a refractive tissue, bending light to assist form a picture on the photoreceptor layer of the retina, makes modern refractive surgery possible. Such surgery uses knife cuts and lasers to reshape the cornea to change and correct its optical properties.

Physiology

Corneal transparency depends on [1]:

- Active deturgence: the endothelium is comparatively permeable. A passive flow of water and nutrients from the intraocular aqueous humor is drawn across into the stroma ('stromal swelling pressure'). to prevent overload (oedema) and maintain its transparency, the endothelium pumps sodium (Na +) back out into the aqueous by active Na + K + ATPase, along with a passive movement of water. Water may pass through hormonally mediated aquaporins, e.g. AQP1. The epithelium is relatively impermeable due to the presence of apical tight junctions.
- Regular orientation and spacing of stromal collagen fibers: this reduces diffractive scatter of light. After injury, loss of architecture may result in opacity and scarring and that and light scatter.

Refraction - The cornea accounts for 70% of the eye's total dioptric power. The radii of curvature of the anterior surface is 7.7mm; the posterior surface is 6.8mm. The cornea could be a robust, elastic surface. Its shape is maintained by structural rigidity and IOP.

Nutrition and nerve supply - The cornea is avascular and relies upon diffusion from the limbus and aqueous for nutrition. Langerhans cells (antigen-presenting cells) are present within the epithelium but are usually restricted to the outer third. the primary division of the trigeminal nerve forms stromal and subepithelial plexi responsible for corneal sensation.

Examination

Firstly per ocular area should be examined with a penlight [4]. Any abrasions, hemorrhages, edema, foreign bodies, bone deformities, and ptosis within this area should be noted. Before checking for the integrity of the world, any sign of an open wound, prolapsed tissue, chemosis, hemorrhage, and foreign bodies regarding the world should be taken into account. If the lids are swollen and with edema, the lids should be opened with lid retractors carefully, and ocular tissues should be examined. Any maneuver that would cause the increase in pressure towards the world should be avoided. Tarsal conjunctiva which is found under the eyelids should be checked by turning the eyelids. Conjunctival tissue integrity must be examined thoroughly for any laceration that may be overlooked easily.

Presence of subconjunctival hemorrhage and chemosis usually impedes examination of sclera. In these circumstances, an exploration with a topical anesthetic can validate the integrity of the sclera. If a posterior scleral injury is suspected, associated pathologies should be evaluated via ultrasonography or CT.

The cornea and limbus are examined carefully with biomicroscopy. in a very thorough corneal examination, one should be careful for corneal erosions, the presence of corneal or conjunctival foreign body, any secondary changes in the deep layers of the cornea subsequent to trauma. Status of anterior chamber, iridocorneal angle, and also the lens must also be examined for any accompanying pathologies. Corneal erosions or epithelial injuries may be visualized better if dyed with vital stains like fluorescein or rose bengal.

All cases should be questioned for any history of refractive surgery. A history of radial keratotomy, PRK, LASİC, clear corneal incision, or corneoscleral incision can give clues about current status of cornea. All cases with the history of corneal incision bear the risk of post-traumatic laceration. Thus, previous cataract surgery or other refractive surgical procedures may cause disruption of the integrity of the world.

The most important point of the slit-lamb examination of penetrating eye trauma is whether or not there's a leakage from the location of the injury or not. Any aqueous efflux through cornea is checked with Seidel test, which might be performed by examining the cornea with cobalt blue light after a fluorescein strip being placed on conjunctiva. If there's any leakage, one should expect a prospect up at the location of yellow staining or a green efflux at the location of the injury.

Although it is not very simple to conclude that the integrity of the globe has been disrupted, some finding may suggest such an injury. some of these findings will be listed as 360 ° subconjunctival hemorrhage, 360 ° dense chemosis (jelly-roll chemosis), significant changes within the depth of the anterior chamber compared with the other eye, disruption of the integrity of the lens capsule, or focal cataracts. Iris transillumination defects can also refer to a foreign body trauma.

In cases with a prominent rupture of the world, within which intraocular tissues are prolapsed, a metal shield should be placed after the examination till the scheduled operation in order to prevent further tissue prolapse.

Examination of the pupilla may reveal an intracranial pathology or a direct trauma to the optic nerve. Relative afferent pupil defect is also substantial for evaluation of optic nerve functions.

Complete examination of the uninjured globe is also an essential step in traumatic globe injuries. In some cases, serious injuries may be overlooked due to an inattentive examination of the other eye.

Dry Eye

Dry eye is a condition within which there's a decrease within the secretion of tears or a decrease in their quality [5]. Tears form a smooth surface of the eye that has a large share in achieving acuity, ensures the passage of oxygen to the cornea and moisturizes the surface of the cornea and conjunctiva. The results of these changes is insufficient eye moisture. Tears are important for overall eye and vision health. whenever when someone blinks, a layer of tears spreads sort of a protective film on the front of the eye. If it doesn't blink often enough, dry areas can form on the surface of the eye, which might cause a decrease in visual modality. Although dry eye syndrome can occur at any age, the risk continues to be higher in people over the age of fifty, especially in women, which is related to hormonal changes.

Dry eye syndrome occurs either due to insufficient tear secretion or due to disturbances within the quality of the tear film. Tears are necessary for lubrication, nutrition, health and optical functions of the anterior surface of the eye and clear vision. additionally, they reduce the chance of infection, flush foreign bodies out of the eye and keep the surface of the eyes smooth and clean. With each blink of an eyelid, tears cover the front surface of the eye. Excess tears within the eye flow into the tiny drainage canals within the inner corner of the attention and further into the nasal cavity. Signs of dry eye syndrome are fibrous secretions and dry spots on the cornea within the area of the interpalpebral opening where the epithelium of the cornea and conjunctiva is exposed to evaporation, unlike the upper a part of the cornea which is protected by the eyelid.

Dry eye syndrome typically feels better within the morning and it doesn't cause sharp, acute pain [6]. we must always examine the patient for lagophthalmos (eyes still partially open after closing gently), which may cause pain within the morning, but the exposure keratopathy of lagophthalmos usually doesn't cause severe, sharp pain. This scenario above would be most consistent with recurrent corneal erosions. Most commonly, a patient notes a history of corneal abrasion with a pointy object like a paper cut or a fingernail. The abrasion elevates a layer of the corneal epithelium, which doesn't cement itself back down well. When patients sleep, the eyelid dries to and sticks to the corneal epithelium slightly. When the patient opens their eye, the eyelid pulls that unstable epithelium off—hence the severe eye pain. This classically improves over some hours. Oftentimes, the patient will arrive at the eye doctor with no obvious corneal defects (subtle ones are often present).

The first line of therapy for preventing erosions is an over-the-counter lubricant eye ointment placed within the eye(s) before going to sleep. This prevents the eyelid from sticking to the epithelium. One could consider a bandage lens system as a protective barrier. If these don't help, then one could denude the faulty epithelium. Other alternatives include lasering the epithelium and basement membrane (phototherapeutic keratectomy) or stromal micropuncture (using a 25-gauge needle to scar the epithelium down).

Injury

Cornea is a transparent tissue of our body [7]. A clear cornea is that the key to take care of the normal visual function. When the cornea is damaged by any sorts of trauma, the patient's visual sense will heavily decrease. Some blunt trauma won't break the integrity of the cornea, but it can damage the corneal epithelial cell. If that had happened, the patient can feel vision decreased, pain, shed tears, photophobia, and foreign body sensation. With the assistance of fluorescein strips, we are able to clearly observe it stain the epithelial defect under the diffused cobalt blue light. Sometimes the cornea may suffer from heavy injury; it can destroy the corneal integrity. If the cornea has already developed an entire layer laceration, the humour will leak from the anterior chamber. the applying of fluorescein dye and visualization under a cobalt blue light will reveal leaking humor, termed the Seidel test. Besides that, we also should use narrow slit light to estimate whether or not the foreign body embed into the wound. But after the trauma, corneal stroma is sometimes edema which will affect our examination. it's difficult to work out the exact state of the corneal wound, especially if the foreign body is little. So, we recommend using different angle of slit light to illuminate the wound. When the patient's cornea is broken by chemical material, we might even see the liquidation and protein denaturation of cornea.

Anterior chamber is that the space between cornea and iris. It's filled with clear aqueous humour. In slit light, the anterior chamber is that the distance between the two light bands.

When examining a traumatic patient, we advise the ophthalmologist use slit light to verify the depth of the anterior chamber. If the integrity of eyeball has already been damaged, the distance between two light bands are decrease or disappear. that means the patient may suffer from the penetrating trauma. After we turn the light to a spot, the light beam will contribute to find suspended solids. Besides that, we also advise figuring out some questions. First, with the assistance of scatter light, observe whether or not the bleeding or inflammation exists in anterior chamber. Second, using X16 power illumination, carefully examine whether or not combined with foreign body. Third, if foreign body are often found in anterior chamber, switch to slit light and magnify the view to determine the characteristic of foreign body.

Transplantation

Diseases, infection or damage to the cornea may result in corneal opacity and blindness [8]. Corneal disease is that the second commonest reason behind blindness within the world and is usually related to severe damage to the ocular surface. Corneal blindness is particularly prevalent in less-developed nations where diseases and infections may progress untreated. Diseased and damaged corneas are often surgically removed and replaced with a button of corneal tissue sourced from cadavers (allografts) during a penetrating keratoplasty procedure. Corneal allografts is also successful and remain clear and provide a successful solution for a few, but this is not always the case and recipients may require a second graft or an alternate option. The insufficient number of cadaveric corneas available for transplant could be a serious issue and results from the unsuitability of some donated eyes for transplant, the low levels of organ donation due to religious and cultural factors, a lack of general education and therefore the absence of eye-banking facilities, particularly in developing countries. Some ocular surface disorders can now be treated effectively by newer procedures involving the transplantation of biological entities like autologus limbal stem cells and/or amniotic membrane. However, there are many ocular conditions that are recognised as having a 'high risk of failure' for the transplant of either corneal grafts or limbal stem cell/amnion approaches and these require an alternate option.

Together, these severe cases have left an unmet clinical need that has driven the event of synthetic corneal replacements. Synthetic devices that replace corneal tissue are referred to as 'keratoprostheses' (KPros) and are wont to restore functional acuity (and, less commonly, alleviate pain in conditions like keratopathy) in eyes with severe corneal disease and opacity that carry a poor prognosis for normal corneal transplantation. the perfect keratoprosthesis would be inert and not rejected by the patient's immune system, it might even be inexpensive and ready to maintain longterm clarity. additionally, it'd be quick to implant, easy to examine and allow a wonderful view of the retina.

Technology

In the feld of ophthalmology, the subspecialty of cornea has seen pioneering work in the evolution of technological advances aimed toward aiding diagnosis and treatment [9]. This dates back to the start of the fifteenth century, with Christoph Scheiner's experiments using refections of images from the cornea. Over time, advancements in technology have enabled the development of instruments like the keratometer, keratoscope, pachymeters, tomographer, confocal microscopes, corneal hysteresis, meibography and wavefront analyzers. The components of a comprehensive ocular surface evaluation today include a tomographic assessment of cornea, biomechanical measurements for ocular hysteresis, optical wavefront analysis and tear flm evaluation including meibomian gland function.

Busy clinics with an increasing demand for refractive surgery have led to a paradigm shift in practice patterns. The clinician must his disposal a wide range of tools to perform a comprehensive qualitative and quantitative evaluation of the ocular surface. However, the interpretation of the scans requires a thorough assessment and due to the vast amount of data generated by modern instruments, this could be time consuming. The approach has got to be individualized given the large amount of present variations. additionally, detection of pathology at a subclinical stage can help in timely and more effective management while avoiding complications. The tools for evaluation remain the identical but the diagnostic and therapeutic threshold criteria for various disorders vary—from selecting candidates for refractive surgery to diagnosing meibomian gland dysfunction or detecting early corneal ectasias.

Corneal Power

The corneal power may be assessed with the diagnostic procedures of keratometry and topography/tomography [10]. Keratometry is a measurement of the anterior central corneal curvature and is performed with a manual keratometer, or more commonly automatically. the two basic manual keratometers are the Javal-Schiotz type and also the Helmholtz type. Automated keratometry measures the radius of the curvature of the anterior surface of the cornea from four reflected points approximately 3 mm apart. Topography derives from the Greek words "to place" (topo) and "to write" (graphein), which means to describe a place. this is classically associated with the study of Earth's surface shape; corneal topography is that the study of the shape of the corneal surface. Corneal topographers include the videokeratoscope or Placido-based devices, e. g., Topographic Modeling System (Tomey Corporation, Nagoya, Japan), Keratron (Optikon 2000 S.p.A., Rome, Italy), Zeiss Atlas (Carl Zeiss Meditec AG, Jena, Germany). Tomography derives from the Greek words "to cut or section" (tomos) and "to write" (graphein). In medicine the classic term computed tomography scanning is used for referring to the radiographic technique for imaging a section of an internal solid organ, producing a three-dimensional image. Corneal tomography presents a three-dimensional image of the cornea and is employed for the examination of the front and back surfaces of the cornea together with pachymetric mapping.

A significant problem in determining the true corneal power is that the difficulty to assess the posterior corneal surface. In most keratometric devices the connection between the anterior and posterior corneal surfaces is fixed and estimated supported an empiric "keratometric index". Assessing the optical power of the posterior corneal surface, and specifically it's astigmatism with corneal tomography devices could potentially increase the refractive outcome in lens surgery. This issue is particularly important in IOL calculations of eyes that underwent corneal refractive surgery. As in these procedures corneal tissue is removed for refractive purposes changes, similarly the link between the front and back surfaces of the cornea is altered, invalidating the use of this standardized index of refraction. Currently, the optical biometers that employ corneal tomography, routinely allow measurement of the posterior corneal astigmatism.

It might be concluded that corneal tomography (or topography, when evaluating the posterior corneal surface isn't neccessary) should be performed in patients with irregular, abnormally flat or steep corneas, in eyes with significant astigmatism, after previous corneal refractive surgery, or if it's impossible to achieve accurate keratometric measurements.

Conclusion

Different techniques of refractive eye surgery change the shape of the cornea to reduce the need for corrective lenses or to improve the refractive state of the eye. In many techniques used today, the cornea is reshaped by photoablation using an excimer laser. Synthetic corneas (keratoprosthesis) are also in development. Most are just plastic implants, but there are lenses that consist of biocompatible synthetic materials that encourage tissue to grow together with the synthetic cornea.

References

1. Rauz, S.; Kolli, S. (2018.): „Cornea" in Denniston, A. K. O.; Murray, P. I. (eds): „Oxford Handbook of Ophthalmology, Fourth Edition, International Edition",Oxford University Press, Oxford, UK, pp. 242. - 243.

2. Cerulli, L.; Missiroli, F. (2008.): „Aging of the Cornea" in Cavallotti, C. A. P.; Cerulli, L. (eds): „Age-Related Changes of the Human Eye", Humana Press, Springer Science + Business Media, LLC, Totowa, USA, pp. 45.

3. Thompson, H. W. (2011.): „The Biological and Computational Bases of Vision” in Dua, S.; U, R. A.; Ng, E. Y. K. (eds): „Computational Analysis of the Human Eye with Applications”, World Scientific Publishing Co. Pte. Ltd., Singapore, Singapore, pp. 2. - 4.

4. Cakmak, H. B.; Acar, U. (2016.): „Current Concepts and Management of Severely Traumatized Tissues in the Outer Coatings (The Cornea, the Conjunctiva, and the Sclera) ofthe Globe: Mechanical Injuries” in Sobaci, G. (ed): „Current Concepts and Management of Eye Injuries”,Springer-Verlag London Ltd., London, UK, pp. 19. - 20.

5. Siniša Franjić. “Dry Eye is a Disorder which Commonly Occurs in People Over the Age of 50.” MAR Ophthalmology 3.4

6. Lee, M. S.; Digre, K. B. (2018.): „ A Case-Based Guide to Eye Pain - Perspectives from Ophthalmology and Neurology”, Springer International Publishing AG, Cham, Switzerland, pp. 10. - 11.

7. Hu, Y.; Wang, Q. (2019.): „Physical Examination” in Yan, H. (ed): „Anatomy and Examination in Ocular Trauma”, Springer Nature Singapore Pte Ltd., Singapore, Singapore, pp. 71.

8. Evans, M. D. M.; Sweeney, D. F. (2010.): „Synthetic corneal implants” in Chirila, T. (ed): „Biomaterials and Regenerative Medicine in Ophthalmology”, Woodhead Publishing Limited, CRC Press LLC, Boca Raton, USA, pp. 99. - 100.

9. Grewal, S. S.; Grewal, S. P. S. (2021.): „Artificial Intelligence in Cornea and Refractive Surgery” in Ichhpujani, P.; Thakur, S. (eds): „Artificial Intelligence and Ophthalmology - Perks, Perils and Pitfalls”, Springer Nature Singapore Pte Ltd., Singapore, Singapore, pp. 39.

10. Grzybowski, A.; Kanclerz, P. (2020.): „Recent Developments in Cataract Surgery” in Grzybowski, A. (ed): „Current Concepts in Ophthalmology”, Springer Nature Switzerland AG, Cham, Switzerland, pp. 57. - 58.