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Visual Impairment and Blindness Among Patients with Corneal Pathologies

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Abstract

Epidemiology

Visual impairment and/or blindness are among the major disabilities worldwide affecting every aspect of the life of rhe diasabed and his/her family. According to WHO data,there are 39 million blind people and 285 million visually impaired people. Of 39 million blind people it is estimated that 4.9 million have bilateral corneal blindness (1).

Corneal causes are the fourth leading cause of blindness globally. However, in different parts of the world, the rate of the corneal causes vary (2).Corneal disease is the second leading cause of blindness in developing countries (3). Prevalence of corneal blindness was 0.12 % and that of unilateral corneal blindness was 0.45 % in a rural Indian population with 12899 participants (4). Another study from China also reported 0.1 % prevalence of corneal blindness (5). According to a recent study involving Chinese adult population corneal opacity accounted for 7.3 % of monoocular blindness (6).

In children,the estimated prevalence of blindness is 1.4 million (7). Corneal causes were the most common primary blindng pathologies in children in Nepal (8).

Vision related quality of life is impaired in patients with corneal disease and the most common activity that was found to be affected was difficulty in recognising people from a distance and activities like seeing fallen objects in food (9).

Cornea, Corneal Edema and Scarring

Cornea is the transparent tissue of the globe that lets the entry of the light rays into the eye. It is an avascular tissue 11-12 mm horizontally and 10-11 mm vertically. The average radius of curvature of anterior surface of the cornea is 7.8 mm ranging between 6.7 and 9.4 mm and that of its posterior surface is 6.9 mm ranging between 5.2 and 8.2 mm. (10). The cornea consists of epithelium, Bowman's layer, the stroma , the Descemet's membrane and the endothelium. It has a 78 % hydration level (11). This is provided by membrane properties of epithelium, endothelium and fluid flow properties of stroma. The endothelium has both barrrier function and active pump mechanism. The epithelium also forms a barrier to tear film.

Clearness of the cornea is indispensable for an intact visual pathway. Diseases that lead to loss of corneal transparency may end up with visual impairment/blindness. The main causes for loss of transparency may be listed as chronic edema and opacity formation. Some disease and surgical trauma may lead to endothelial dysfunction and this leads to stromal swelling and ends up in corneal

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edema. This edema distrupts the regular collagen fiber alignment in stroma. In case of persistant edema opacification occurs. In addition to co rneal opacity formation in chronic corneal edema, corneal scar formation also leads to loss of transparency. In case of an surgical insult, trauma or infection, the keratocytes in stroma diffrentiate into myofibroblasts, the inflammatory cells, notably neutrophils invade the stroma (12). Thus, the degrading enzymes are activated and the alignment of corneal fibrils is disrupted. Haze and scar formation is triggered. Transforming growth factor β mediated activation of keratocytes to myofibroblasts is important in this scar formation (13). The myofibroblasts assemble f-actin into stress fibers and express a smoooth muscle action , which gains contractile properties. this wound contraction eventually distorts the corneal shape and curvature besides loss of transparency (14).

Blinding corneal pathologies

The causes of corneal disease that lead to corneal blindness are different in developing countries and in developed countries. Trachoma, onchocerciasis are still major infectious causes leading to corneal blindness in underdeveloped countries. Vitamin A deficiency induced keratomalacia is also an important nutrient dependent cause of corneal blindness (3). While the bacterial and fungal infections of cornea are relatively infrequent in developed areas, they are among the main causes of corneal blindness in developing areas. Viral corneal ulcers, especially herpes simplex virus keratitis are by far the main cause of infectious corneal blindness in developed world (15,16).

Corneal traumas including chemical burns also consitute a major cause of blindness in developing world besides surgically induced bullous keratopathy, particularly after cataract extraction. The other causes such as corneal dystrophies and disease associated bullous keratopathy are the othet causes of corneal blindness in developed countries (3). Cicatrising diseases such as cicatricial pemphigoid and Steven Johnson's syndrome are relatively rare caues of corneal blindness (17).

Treatment

Corneal transplantation is the principal treatment choice in corneal blinding diseases. Penetrating keratoplasty is the full thickness replacement of cornea and is still the main form of corneal transplantation technique worldwide. It has a sucsess rate of 90 % without apparent risk factors for graft rejection. Recently, lameller techniques replacing only the diseased portion of the cornea have evolved and may indications of penetrating keratoplasty changed in favor of lamellar keratoplasty in developed countries. This type of transplantation enables surgeon to use the cornea for two persons, one for anterior lameller surgery and one for endothelial transplantation. In 2012, 1845576 corneal transplants were performed in 116 countries with the indications of Fuchs dystrophy (39 %), keratoconus (27 %) and sequellae of infectious keratitis (20 %). The United Stated had the highest transplantation rate and 53 % of world's population lacked the opportunity of corneal transplantation (18).

There are many other attempts of management alternative to corneal transplantation in some disease or in some conditions in which the prognosis of corneal transplantation is poor such as in failed grafts, limbal stem cell defieciency and cicatrising disease.

Some agents such as steroids have been widely used to prevent corneal scarring after surgeries and in keratitis. Although some scar preventing agents such as rosiglitazone has been found effective in animal model, there have been no established interventions in preventing corneal scar formation. Strategies targeting inhibition of some cytokines , principally transforming growth factor β may be helpful in this context (14).

Artificial corneas replacing opaque cornea are another choice in treatment of patients with extensive scarring and limbal stem cell deficiency states such as in chemical burns, repeat failed grafts and cicatricing diseases. Different keratoprostheses have been developed and used for this purpose (19-21). But these prostheses have high rate of severe complications and require lifelong immune suppression and antibiotic therapy (22,23).

Recently, there has been a substantial amount of effort on making use of biomaterials such as fibrin based corneal and recombinant human collagen corneal implants and on providing corneal stem cells for corneal regeneration (24,25). As dysfunction of corneal endothelium is one of the most common reasons of penetrating or endothelial corneal transplantation, research has also been focused on culturing human endothelial cells, human corneal endothelial cell trnsplantation using different scaffolds and corneal endothelial wound healing promoters such as p-associated protein kinase (ROCK) inhibitor (26).

Prevention

Nearly 80 % of all corneal blindness is avoidable (27). Some public health measures such as infection control and nutritional health improvement, promotion of primary eye care health in underdeveloped parts of the

world may help to decrease the rate of corneal blindness. More specifically, by improving the eye banking facilities and promoting corneal donation the shortage of corneal tissue for transplantation may be overcome.
Lamellar corneal transplantation techniques should be supported and taught in order to to use the single donor cornea in 2 recipients.
Stem cell therapies and tissue engineering seems to be promising in the near future for replacing and repairing diseased cornea.

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