Assessment of the Ocular Effects in Cardiac Catheterization Unit's Medical Personnel Exposed to Ionizing Radiation

Thesis

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By

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List of Abbreviations

Abb.	Full term
ATP	Adenosine tri phosohate
BUT	Break up time test
CCT	Central corneal thickness
CV	Coefficient of variation
D	Diopter
DED	Dry eye disease
DEWS	Dry eye workshop
ECD	Endothelial cell count
ECM	Extra cellular matrix
Fig	Figure
Gy	Gray
HEX%	Percentage of hexagonal cells
ICs	Interventional cardiologists
LOCS	Lens opacities classification system
MUC	Mucin like glycoprotein
MMP	Matrix metalluprotinease
NC	Nuclear color
nm	Nanometer
NO	Nuclear opalescence
OSDI	Ocular surface disease index
PAS	Periodic acid achiff
PSC	Posterior sub capsular
Sv	Siervert
TF	Tear film
UM	Micron
UV	Ultraviolet rays

INTRODUCTION

In the electromagnetic spectrum, radiant energy is classified according to wavelength, frequencies and photon energy. Recent researches that studied the effect of radiation on the ocular lens have focused mainly on microwave (2200-700nm), infrared (1000-750nm), ultraviolet rays (UV) (400-4nm) and on the radiation of 10nm or less wavelength which has been classified as ionizing radiation ***(Bakshi, 2009).***

Radiosensitivity is related to the susceptibility of the cells to ionizing radiation. The corneal epithelium and lens epithelium are more radiosensitive structures than other parts of the eye ***(Bakshi, 2009).***

The cornea is avascular, transparent tissue, which is located in the anterior aspect of the eye. The cornea has 6 layers: corneal epithelium, bowman's layer, the corneal stroma, Descemet membrane, dua layer, and the corneal endothelium ***(Williams et al, 2016).***

The corneal epithelium acts as a natural barrier against radiation and although the cornea blocks UVB, UVC but UVA can penetrate full-thickness cornea.

In the electromagnetic spectrum, X rays have very high frequency and carry higher energy than UV rays so, cause more cell damage than UV rays ***(Brenner et al, 2007).***

Cataracts are the most frequently reported finding in the literature, which can develop in one or both eyes. A characteristic, dose-dependent progressive lens opacification usually occurs as a result of ocular exposure to ionizing radiation ***(Williams et al, 2016).***

Clinically, cataract presents three main forms: posterior subcapsular (PSC), cortical, and nuclear. Although it is the least common type, PSC results in a significant impairment of vision owing to its location along the vertical axis of the lens. Furthermore, PSC is the most prevalent radiation-induced type. Optic neuropathy and chorioretinopathy related to radiation exposure have also been studied clinically ***(Worgul et al, 2007).***

Keratopathy is another form of complication associated with ionizing radiation. Merriam et al reported that a dose of 6000 rad within 5–6 weeks caused corneal ulceration in three of 25 patients treated for orbital tumors ***(Brown et al, 1982).***

The conjunctiva is a thin transparent mucous membrane that covers the sclera of the anterior globe and reaches anteriorly to line the eyelids. The nonkeratinized epithelium of the bulbar conjunctiva is continuous with that of the cornea and shares characteristics such as elongated basal cells and flattened surface cells. Chronic exposure to UV especially solar exposure has been implicated in several diseases that involve the interpalpebral conjunctiva including dryness, pinguecula, pterygium, hyperkeratosis, carcinoma-in-situ and squamous cell

carcinoma. Clinically, its presence is determined by injected conjunctival blood vessels, edema (chemosis) and damaged epithelial cells, which stain with rose Bengal ***(Dua and Said, 2008)***.

Specular microscopy is a technique of viewing the corneal endothelium. It is a standard method for determining cell loss or changes in cell size (polymegethism) or cell shape (pleomorphism).It has been used to evaluate the cornea following refractive surgery and ultraviolet irradiation ***(Levin et al, 2000).***

Only one study was conducted on radiology technicians to show the corneal endothelial cell morphology and reported no change in radiology technicians so, we need further studies to demonstrate the corneal effects of ionizing radiation.

AIM OF THE WORK

The main aim of our study is to investigate the long-term influence of the ionizing radiation on corneal endothelial cells, lens and tear film stability.

So, we will measure the Endothelial cell density (ECD), the central corneal thickness (CCT), the coefficient of variation (CV) and the percentage of hexagonal cells (HEX%) using specular microscopy (Nidek CEM-530).

We will assess also the degree of cataract development & correlate degree of dryness to time of exposure using slit lamp examination in health care providers in cardiac catheterization units exposed to ionizing radiation.

Chapter 1

ANATOMY OF THE CORNEA

The cornea is a transparent avascular tissue that acts as a structural barrier and protects the eye against infections. Along with the tear film, it provides a proper anterior refractive surface for the eye. The cornea contributes to two-third of the refractive power of the eye ***(DelMonte and Kim, 2011)***.

The cornea is horizontally oval, measuring 11–12 mm horizontally and 9–11 mm vertically ***(Fares et al, 2012)***. The cornea is convex and aspheric. The anterior curvature is 7.8 mm and the posterior curvature is about 6.5 mm. The cornea contributes to about 40–44 Diopter (D) of refractive power and accounts for approximately 70% of total refraction. The refractive index of cornea is 1.376. There is a gradual increase in thickness from the central cornea to the periphery ***(Feizi et al, 2014)***.

The cornea is made up of cellular and acellular components. The cellular components include the epithelial cells, keratocytes, and endothelial cells. The acellular components include collagen and glycosaminoglycans. The epithelial cells are derived from epidermal ectoderm. The keratocyte and endothelial cells are derived from the neural crest. The corneal layers include epithelium, Bowman's layer, stroma, Descemet's membrane and endothelium as shown in

Figure (1). Recently, a layer of the cornea that is well defined, acellular in pre-Descemet's cornea is getting attention with the development of lamellar surgeries ***(Dua et al, 2013)***.

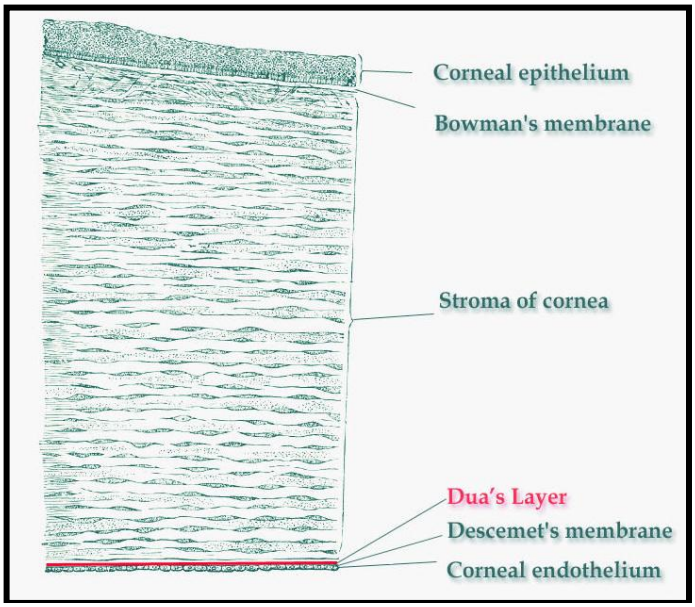

Figure (1): Layers of the cornea ***(Dua et al, 2013)***.

The corneal epithelium is composed uniformly of 5–7 layers of cells. It is about 50 μ in thickness. The epithelium is uniform to provide a smooth regular surface and is made up of nonkeratinized stratified squamous epithelium. as shown in (figure 2).

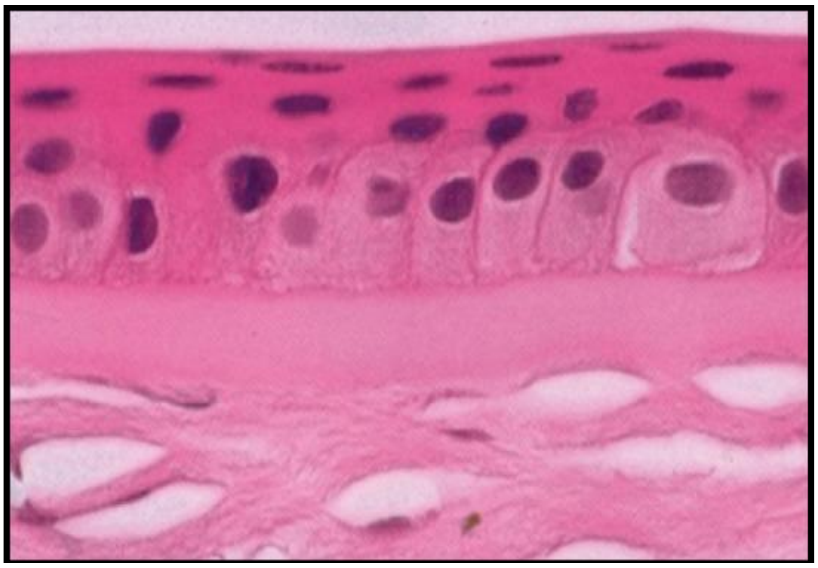

Figure (2): Histopathology of corneal epithelium and Bowman's membrane ***(Fares et al, 2012)***.

Corneal epithelial cells have a lifespan of 7 to 10 days undergoing involution, apoptosis and desquamation. The epithelium is a 5–6 layers structure with three types of cells: superficial cells, wing cells and basal cells. The superficial cells are 2–3 layers made up of flat polygonal cells.

Desmosomes form the tight junction between the superficial cells. Wing cells are 2–3 layered and are named as they have wing like shape. Basal cells are a single layer of the epithelium which is cuboidal or columnar. They have abundant organelles and they are active mitotically.

The deepest cell layer of the epithelium is the basal layer, which compromises the single-cell layer of epithelium approximately 20 μ tall. Besides the stem cells and transient