ORIGINAL ARTICLE

Management of Cataract in Avicenna's *Canon of Medicine*

Esmaeil Shabaninezhad[1]
Samaneh Soleymani[2]
Mohammad R. Khalili[3]
Alireza Mehdizadeh[4]
Arman Zargaran[2, 5]

1- MD, Ophthalmology Department, Baghiatallah University of Medical Sciences, Tehran, Iran
2- PharmD, PhD, Department of Traditional Pharmacy, School of Persian Medicine, Tehran University of Medical Sciences, Tehran, Iran
3- MD, Department of Ophthalmology, Faculty of Medicine, Shiraz University of Medical Sciences, Shiraz, Iran
4- MD, PhD, Research Office for the History of Persian Medicine, Shiraz University of Medical Sciences, Shiraz, Iran
5- PharmD, PhD, Department of History of Medicine, School of P ersian Medicine, Tehran University of Medical Sciences, Tehran, Iran

Correspondence:
Arman Zargaran
PharmD, PhD, Department of History of Medicine, School of Persian Medicine, West Jamali Alley, Vafamanesh Street, Heravi Sq., Tehran, Iran
azargaran@sina.tums.ac.ir

Abstract

Cataract is mentioned as one of the most important blindness factors in the world. Management and treatment methods of cataract dates back to antiquity. Avicenna is one of prominent Persian scientists that played an important role in the development of ophthalmology in ancient Persia. In this review, Avicenna's points of view about cataract is discussed in the *Canon of medicine* and compared with the current medicine. Cataract or "*Nozol-al-maâ*" is an obstructive disease due to the accumulation of a dense liquid layer between the lens and cornea. Avicenna categorized cataracts based on their density, size and color. To treat and manage cataract, he took three approaches: changing life style and nutrition in the first step; using simple and complex medicines in the next step; and performing surgery in the last stage. Nowadays, in vivo and in vitro studies have proven the effects of some food, nutraceuticals and medicinal plants in preventing cataractogenesis progression. As surgery is the only remedy of cataract today and postoperative problems may occur, finding new non-surgical procedures can be noteworthy.

Key words: Persian medicine, Eye diseases, Cataract, History of medicine

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Introduction

Cataract is mentioned as one of the blindness factors all around the world. Based on WHO report, cataract was the cause of blindness of about 17 million of total 37 million blind people in 2002 and it will increase to 40 million in 2020 (Bobrow, 2009, no page). Definition and case report of the management and treatment of cataract dates back to antiquity. The first documented cataract is on a statue from the fifth dynasty (about 2757-2767 BC) of Egyptians, kept in the Egyptian Museum in Cairo (Ascaso and Huerva, 2013, pp. 75-80). For the first time, Sushruta, the Indian physician, clearly and unambiguously described extra capsular removal procedure in the 5th century BC (Mehta, 2011, p. 276). Later, the couching technique was, widely used in ancient civilizations, such as China, Persia, Greece and Egypt (Chan, 2010, pp. 393-398; Lascaratos and Marketos, 1997, pp. 151-159; Swan, 1995, p. 208). In medieval period, Islamic scholars, such as Albucasis (936-1013 AD), improved surgical approaches including the cataract surgery (Mehdizadeh, 2012, pp. 75-76). Also, definition, diagnosis and non-surgical treatment of cataract were progressed by Islamic doctors, especially Persian scholars during the Islamic golden age of science (10th-14th AD) (Nejabat et al, 2012, p. 265). Ibn Sina (980-1032 AD), the Persian physician who was known as Avicenna in the west, was one of the most prominent and influential scientists in the medieval period. He wrote about 450 treaties on various subjects, such as medicine, philosophy and astronomy. His large encyclopedia in medicine, *the Canon of Medicine*, became one of the most important medical references in the west and east until the 17th century AD (Soleymani, 2018, pp. 65-69). This book has 5 volumes, the third volume being about Ophthalmology. Cataract was discussed under the title "*Nozul al-maâ*" in this volume. It encompasses pathology, diagnosis, signs and symptoms and finally treatment approaches of cataract (Avicenna, 1998, pp. 385-390). In the present study, we attempted to introduce this section of *the Canon of Medicine* and discussed about Avicenna's points of view about cataract. Also, we compared his concepts with that in the current knowledge of medicine to evaluate the 10th century knowledge about cataract and its capacities to use in current era.

Materials and Methods

This article is based on library documents including medical manuscript, *the Canon of Medicine*. Furthermore, current investigations about this subject have been undertaken and then the findings have been compared with the current knowledge of ophthalmology. In this regard, numerous articles were searched in scientific databases, such as PubMed, Scopus and Google scholar.

Results

Pathology

Avicenna believes that cataract is formed due to the accumulation of a dense liquid layer between cornea and lens. This layer can prevent the light from reaching the eyes. He denotes that this layer has external origin. According to *Canon*, this layer is smooth and clear or dens. The book, based on their colors including no color, plaster color, pearl color, gray, Turquoise color, golden, yellow, black, light brown and green, has classified cataract into 10 groups. The importance of these colors is in facilitating the diagnosis and prognosis of the disease (Avicenna, 1998, pp. 385-390).

Signs and symptoms

Avicenna mentioned some signs and symptoms to diagnose the disease as below (Avicenna, 1998, pp. 385-390):

- Seeing dark shadows and small masses as preliminary signs of the disease
- Diplopia
- Bleared vision
- Blindness

Treatment

Avicenna mentioned three approaches to treat and manage cataract. Nutrition and changing life style are in the first line. In the next step, ophthalmic medicines as well as surgery, in the last line, was suggested in *the Canon* of Avicenna. These approaches are explained and discussed in below sections (Avicenna, 1998, pp. 385-390).

1- Nutrition and changing life style

Avicenna believed that, in initial stages, cataract can be managed by some nutritional and behavioral advice. The patient should avoid eating watery food, beef, fish and fruits. Also, he should refrain from eating excessive amount of food, having too much intercourse and drinking excessive number of alcoholic beverages. On the other hand, he suggested the patient eat dry foods, such as partridge meat and whole meal bread. Furthermore, he recommended that these patients use spices, such as Cinnamon (*Cinnamomum verum* J. (Presl)), Thyme (*Zataria multiflora* Boiss.), Ginger (*Zingiber officinale* L.) and Fennel (*Foeniculum Vulgare* L.) in foods.

2- Medicines

Avicenna always suggested simple prescriptions to treat diseases and disorders. He prescribed smooth and simple medicines, such as Fennel aqueous extract with honey and olive oil as well as pastel, to be applied into the eyes. Furthermore, he advised smelling Marjoram oil because he believed it can exsiccate the liquid layer. Then, in more complicate cases, Avicenna suggested some other compound formulations shown in Table 1. The first four formulas were used in initial stages and others were applied in later stages and in more complicated cases.

3- Surgery

Avicenna considered surgery as the last choice in the treatment of end stage cataract (Avicenna, 1998, pp. 385-390). He denoted that: “Don’t hurry in operation, let the liquid stops and became dense” (Avicenna, 1998, pp. 385-390). Also, the patient with severed cough, depression or mania is not a good candidate for surgery. Before operation, phlebotomy is forbidden. Diet regime is changed. It includes fresh fish, wet food and tonics. Finally, when the cataract becomes dense enough, operation can be done.

According to *Canon*, the patient should look at his/her nose and do not change his/her position. Also, the patient should not be put in front of the window. Moreover, the operating room should not be very bright. The surgeon put the instrument (axis like) into the eye via iris hole. Then, the cataract should be pressed and put to the backside of the cornea by the instrument. Avicenna holds that while some types of cataracts can be treated,

in case of some other types, healing is not complete. Furthermore, patient-care after the operation is very important. A cotton salve impregnated with volatile oil and yolk should be put on the operated eye immediately. Both eyes should be fastened to avoid eye movement. Also, patient had to sleep in a dark place for 3 to 7 days. Salve should be changed frequently during this period.

On the other hand, there is another common operation, which according to Avicenna, is dangerous. In this method, bottom of the cornea is cut to remove the cataract. Avicenna holds that if the cataract is unexpectedly big, this method could cause blindness.

Table 1: Seven Avicenna's prescriptions for cataract

Prescription number	Procedure of preparing
1	*Ferula persica* (3 unit), *Ferula assa-foetida* (1 unit), *Gypsophila struthium* (1 unit), Honey (8 ghotooli*)
2	The young bull bile was slaughtered in a cupreous bowl and kept for 10 to 14 days. Then *Commiphora habessinica*, pulverized *Crocus sativus*, *Commiphora gileadensis* oil and turtle bile (of each 2 ***dram*) were mixed up and used in the eye.
3	*Veratrum album* (1 unit), *Ferula assa-foetida* (1 unit) and *Ferula persica* (0/3 unit) were made as ophthalmic suppositories
4	Ophthalmic suppositories from *Veratrum album* (1 unit), *Piper nigrum* (1 unit), mineral salt (3 unit) with *Raphanus sativus* juice
5	*Acacia senegal* (1 unit) and *Laurus nobilis* peeled fruit (2 unit) in immature boy urine were pulverize as well
6	The snake poison and Honey were combined, then applied in the eye.
7	*Teucrium chamaedrys*, *Carthamus tinctorius* and Coral (of each ***1 mesghal) with Fennel juice were blended and used in eye.

Weights used in Persian medicine: *One oghotooli = 241/5 gram, **One *dram* = 3/2 gram, *** One mesghal = 4/6 gram

Discussion

Cataractous-opacification of the lens is the main cause of blindness in the world, happening because of clouding of eye's natural lens (Kyselova, Stefek, and Bauer, 2004, pp. 129-140). Avicenna was one outstanding Persian physicians who played a main role in the progression of ophthalmology in ancient Persia (Khodadoust, 2006, pp. 1481-1483). He emphasized on cataract treatment through nutrition and medicines rather than surgery in its early stages. Furthermore, he believed that the patient's psychological and mental status played a significant role in the success of cataract surgery (Avicenna, 1998, pp. 385-390).

He also introduced various medications for cataracts in *the Canon* that are potential research topics for pharmacologists and ophthalmologists.

At present, there are studies, including laboratory experiments, both in vivo and in vitro, that propose food, nutraceuticals and medications in preventing and treating cataract and in maintaining the transparency of the lens. It is broadly admitted that oxidative stress is a significant factor in the development of cataractogenesis (Gupta et al., 2003, pp. 794-799; Truscott, 2005, pp. 709-725). Antioxidants are smain prophylactic agent in prohibiting oxidation-related cataractogenesis. A great number of interventional and epidemiological studies have assessed the role of dietary antioxidant supplement in the occurrence of cataract. Several classes of antioxidants that can be applied to prevent cata-

ract are carotenoids, flavonoids, tocopherol, ascorbic acid, pyruvate and caffeine (Meena et al., 2010, pp. 178-181; Watkins, 2002, pp. 59-60). Vitamin E, which is found mainly in wheat germ oil and corn oil, is effective against steroid, galactose and UV radiation-induced cataract (Gupta et al, 2009, p. 175). Amongst all carotenoids, that are natural lipid-soluble antioxidants, lycopene has a great antioxidative activity, protecting against sugar-induced diabetic and oxidative stress-induced experimental cataract (Clinton, 1998, pp. 35-51; Cumming, Mitchell, and Smith, 2000, pp. 450-456; Mohanty et al, 2002, pp. 347-354). Two dietary carotenoids: zeaxanthin and Lutein, can be beneficial in the prevention of cataract by decreasing light-induced oxidative damage caused by ROS (Gao et al., 2011, p. 3180; Krinsky, Landrum, and Bone, 2003, pp. 171-201). Flavonoids that have antioxidant properties, such as quercetin, diosmetin, apigenin, naringenin, kaempferol, catechin and flavones, can be obtained from fruits, including grapes, apple, cherries, berries, bananas and from green leafy vegetables (Meena et al., 2010, pp. 178-181). Grape seed extract (GSE), a rich source of proanthocyanidins, is a dietary supplement that have potent antioxidant activity by impressing numerous signaling pathways, such as inhibiting aldose reductase and lens epithelial cell apoptosis, and thus is useful in suppressing cataracts (Durukan et al., 2006, pp. 1041-1045; Jia et al, 2011, p. 210).

In recent year, a large number of medicinal herbs and their formulations, containing antioxidant properties, which can protect the eyes against cataract, are introduced. The medicinal herbs mentioned in this paper are listed in Table 2.

Curcuma longa (turmeric): Curcumin is the active principle of turmeric, and owing to its antioxidant, aldose reductase inhibitors, and antiglycation properties can delay or prevent the development of cataract (Suryanarayana, Krishnaswamy, and Reddy, 2003, pp. 223-230).

Foeniculum vulgare (Fennel): Trans-anethole in Fennel has efficiently demonstrated the anti-cataract activity by decreasing catalase, glutathione activity and enhancing soluble lens protein, on in vitro cataract (Dongare et al., 2012, pp. 385-390).

Crocus sativus (Saffron): Saffron extract, through decreasing the lipid peroxidation and rein-forcing the antioxidant property and prohibiting the proteolysis of the lens, can suppress cataract formation in Wistar rats (Makri et al, 2013, p. 1188).

Trigonella foenum–graecum (fenugreek): A number of studies have demonstrated that the seeds of fenugreek because of their antioxidant status have anti-cataract effects in selenite-induced in vivo and in vitro cataract (Gupta et al, 2010, pp. 258-268; Vats et al, 2004, pp. 289-294).

Emblica officinalis (Amla): Fruits rich tannoids of Amla is effective in delaying the development of diabetic cataract (Suryanarayana et al, 2007, pp. 1291-1297).

Vaccinium myrtillus (bilberry): In a clinical trial of fifty patients with senile cataracts, a combination of vitamin E and bilberry stopped the development of cataracts up to 96% (Bravetti, 1989, p. 109; S. Gupta et al., 2009, p. 175).

Nowadays, surgical removal of the lens and replacing it with a lens prepared of synthetic polymers is the only remedy of cataract (Gupta et al., 2009, p. 175). Postoperative complications can happen, including endophthalmitis, posterior capsular opacification, and uncorrected residual refractive error (Varma and Hegde, 2004, pp. 913-918). So, the application of nutritional and pharmacological strategies seems to be necessary in preventing cataract progression and prohibiting other risk factors responsible for catarac-

togenesis.

Table 2: Medicinal herbs which were mentioned in this manuscript: their Persian, English common and scientific names

Scientific name	Part use	Persian Traditional name	Common name
Foeniculum vulgare Mill.	Fruit	*Razianeh (Badiyan)*	Fennel
Dorema ammoniacum Don.	Gum	*Oshagh*	Ammoniac Gum
Ferula persica Willd.	Gum	*Sakbinaj*	A kind of Ferula (makes sagapenum gum)
Ferula assa-foetida L.	Gum	*Heltit*	Asafoetida
Gypsophila struthium Loefl.	Root	*Kondos*	Gypsophila
Commiphora gileadensis (L.) C.Chr.	Oleogum	*Balsan*	Balsam of Mecca
Euphorbia resinifera O.Berg	Latex	*Farfiun*	Resin spurge
Citrullus colocynthis (L.) Schrad.	Fruit	*Hanzal*	Colocynth
Olea europaea L.	Fruit	*Zeitun*	Olive
Origanum majorana L.	Aerial parts	*Marzangoush*	Marjoram
Teucrium chamaedrys L.	Root	*Komadrius or Maryam Nokhodi*	Wall germander
Carthamus tinctorius L.	Seed	*Fanaghdasi*	Safflower
Acacia senegal (L.) Willd.	Gum	*Samgh-e-Arabi*	Gum Arabic
Raphanus sativus L.	Root	*Torob or Fojl*	Radish
Laurus nobilis L.	Fruit peel	*Ghar*	Bay Laurel
Piper nigrum L.	Fruit	*Felfel*	Pepper
Veratrum album L.	Skin	*Kharbagh-e-Sefid*	White Hellebore
Crocus sativus L.	Flower	*Za'faran*	Saffron
Commiphora habessinica (O.Berg) Engl.	Gum	*Morr*	Myrrh
Viola odorata L.	Flower	*Banafsheh*	Sweet violet
Salix aegyptiaca L.	Juice	*Bidmeshk*	Musk willow

Conclusion

Nowadays, surgery is the first line and the most effective procedure of the treatment of cataract. In some cases, eyeglasses and pupil dilation are suggested (Bobrow, 2009, no page). In this regard; finding new non-surgical procedures can be valuable. Reviewing the historical evidence can be valuable to find new ideas in treatment. Traditional approaches applied by Avicenna can be helpful in further investigations to find new treatments for cataract. Furthermore, this study can shed light on some obscure history of medicine. It can show us the progress of the cataract concepts, diagnosis and treatment in the 10th century AD.

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