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Asteroid hyalosis – current state of knowledge

Bielenie skrzące – aktualny stan wiedzy

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Summary: The search query into the Cochrane Library, Medline, Web of Science, Embase, Scopus and ScienceDirect enabled selection of research papers addressing the issue of asteroid hyalosis published in English between 1963 and January 2014. Asteroid hyalosis is a degenerative condition of the vitreous in which small, creamy or white, spherical particles (asteroid bodies) are randomly diffused within the vitreous. They consist mainly of calcium and phosphorus and have a structure of hydroxy lapatite. In 80.2–92.0% of cases the condition affects one eye only and it occurs in 0.36–1.96% of population, mostly in patients over 50 years of age and in males. Hypercholesterolemia and hypertension are systemic risk factors, but asteroid hyalosis is postulated to occur more often in retinitis pigmentosa and Leber amaurosis caused by mutations in lecithin retinol acyltransferase gene. Asteroid hyalosis also causes calcification of some intraocular lenses – mostly silicone ones. Vitreous of patients with asteroid hyalosis shows reduced gel liquefaction and anomalous vitreoretinal adhesion.

Key words: asteroid hyalosis, risk factors, prevalence.

Streszczenie: Z zasobów baz Cochrane Library, Medline, Web of Science, Embase, Scopus, ScienceDirect wybrano artykuły dotyczące bielenia skrzącego, które opublikowano w języku angielskim od początku 1963 roku do stycznia 2014 roku, i je przeanalizowano. Bielenie skrzące jest formą degeneracji ciała szklistego – niewielkie kremowożółte lub białe cząsteczki (ciałka gwiaździste), zbudowane głównie z wapnia i fosforu, są luźno zawieszone w ciele szklistym. Częstość występowania bielenia skrzącego w populacji ogólnej waha się od 0,36% do 1,96% – ta forma degeneracji głównie jest spotykana u osób, które ukończyły 50. rok życia, mają hipercholesterolemię, nadciśnienie tętnicze, częściej u mężczyzn, w 80,2–92,0% przypadków schorzenie występuje tylko w jednym oku. Niektóre badania wskazują na korelację bielenia skrzącego ze zwyrodnieniem barwnikowym siatkówki oraz ślepotą Lebera wywołaną mutacją w genie acylotransferazy lecytyna–retinol. Bielenie skrzące jest przyczyną kalcyfikacji niektórych soczewek wewnątrzgałkowych – przeważnie silikonowych. Ciało szkliste w oczach z bieleniem skrzącym jest słabo uwodnione oraz mocno przylega do powierzchni siatkówkowej.

Słowa kluczowe: bielenie skrzące, czynniki ryzyka, częstość występowania

Introduction

Asteroid hyalosis (AH), described for the first time by Benson in 1894 (1), is a rare degenerative condition of vitreous. It used to be called asteroid hyalitis in the past, as it was thought to be a sign or manifestation of an inflammation. The other terms coined for this condition were: Benson's disease, asteroid bodies, and scintillation nivea. It can be diagnosed by fundus photography or slit lamp examination. It can also be visualized by ultrasounds and optical coherence tomography (OCT). Clinically, it is characterized by creamy or white spherical bodies (Fig. 1a.), called asteroid bodies (ABs), which follow the eye movement and are randomly diffused within the vitreous. Sometimes they form chains or sheets. In ultrasound and OCT examinations ABs are seen due to presence of calcium in their structure. They form small, mobile and hyperechogenic echoes within the vitreous (Fig. 1b., 1c.).

The prevalence of AH is between 0.36% to 1,96% (2–6). Only in rare cases patients with asteroid hyalosis suffer from decreased vision or other visual disturbances. Vitrectomy can be performed if low vision is caused by dense asteroid bodies or if it is difficult to visualise the fundus, as seen in diabetic retinopathy (7). In most cases asteroid hyalosis is a unilateral

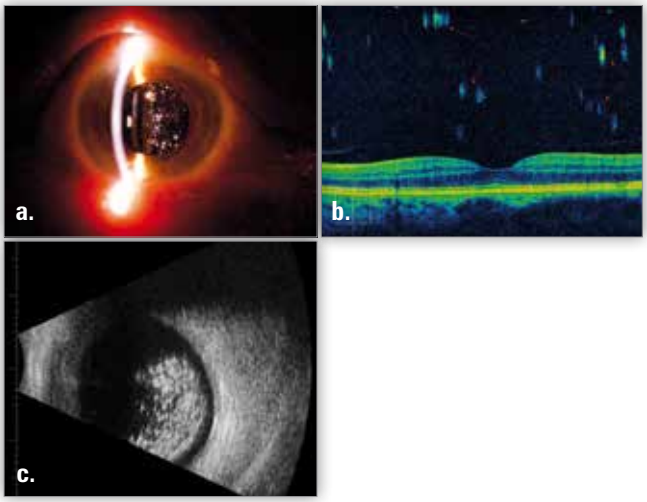

Fig. 1. Asteroid hyalosis: color photography of slit lamp examination in a patient with asteroid hyalosis – a., asteroid bodies in OCT (arrows) – b., asteroid bodies in ultrasound – small hyperechoic echoes within vitreous – c.

Ryc. 1. Bielenie skrzące: kolorowe zdjęcie oka pacjenta z bieleniem skrzącym – a., ciałka gwiaździste w obrazie badania OCT (strzałki) – b., ciałka gwiaździste w obrazie badania USG – małe hiperechogenne struktury w ciele szklistym – c.

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condition, but it can occur bilaterally in 8.0–19.8% (2–6, 8). The prevalence is age-related. Asteroid hyalosis usually occurs in people above 50 years of age, mostly in their seventh or eighth decade of life. Males tend to develop the condition more often than females (5–6). Until today, the mechanism and etiology have not been known. First reports suggested correlation between asteroid hyalosis and diabetes (3, 9, 10), hypercholesterolemia (2), hypertension (2–3, 11), gout (12), hyperopia (3, 11), increased serum calcium levels (10), higher body weight, and significant alcohol consumption (5). Additionally, in autopsy population, ABs were more common with posterior vitreous attachment and age-related macular degeneration (4). Later, a Korean study pointed out to the association of AH with stroke history (2). However, the pathogenesis and systemic factors are disputable and not conclusively confirmed.

Structure of Asteroid Bodies

Ultrastructural studies with electron microscopy (13–14) and X-ray diffraction proved that ABs mainly consist of calcium and phosphorus and they form hydroxyapatite crystals.

Vitreoretinal Interface

Pathophysiology of vitreoretinal interface in patients with AH is not well-known. First reports suggested complete posterior vitreous detachement (PVD) rate of 24.0–38.0% in AH (9). However this study analyzed slit lamp examination only. To improve visualization of the fundus and minimalise asteroid distortion, fluorescein angiography was performed (7, 15). OCT provides additional information about the vitreous and the retina. At the same time it does not require advanced technical skills from the examiner, such as focusing the camera or injecting fluorescein (15). It is important especially in cases of dense AH when it is difficult to control possible vitreous and macular changes (16–17). Mochizuki suggested that the percentage of complete PVD, revealed by OCT, is lower than in previous studies with slit lamp examination only (16). Vitreous of patients with AH shows reduced gel liquefaction and anomalous vitreoretinal adhesion (9, 16). This may cause anomalous posterior vitreous detachment associated with vitreoschisis (18), residual vitreous cortex on the retina (11, 18) and such vitreoretinal diseases as macular hole or epiretinal membrane (11, 19, 20). Reduced gel liquefaction and anomalous vitreoretinal adhesion in eyes with AH also lead to complications during vitrectomy (21). In most cases intravitreal administration of triamcinolone acetonide is necessary for a complete removal of residual vitreous cortex (16, 21).

Epidemiology and Risk Factors

Asteroid hyalosis is a rare condition of the vitreous body. The prevalence differs between the studies (Table I). It occurs in 0.36% of the Korean population (2), 0.89% of the Chinese population (22), 0.83% of the American population (3), 1.0% of the Australian population (6), and 0.48–1.2% of the British population (5, 23). It was also revealed in 1.96% of the autopsy population (4). Age of affected individuals usually ranges from

Study/ Badanie	Type of study/ Rodzaj badania	Population/ Populacja	AH, n, (prevalence, częstość, %)	Study group size/ Grupa badana	Male/ Mężczyźni (%)	Age/ Wiek	Bilateral cases/ Obuoczne AH n (%)
Kim JH, et al. (2)	Cross-sectional, population based	Asian, Korean	33 (0.36)	9050	21 (63.64)	≥ 40	4 (12.12)
Bergren, RL, et al. (3)	Cross-sectional, population based	American	101 (0.83)	12205	49 (48.51)	35–97	19 (18.81)
Fawzi, AA, et al. (4)	Cross-sectional, population based	American, autopsy population	212 (1.96)	10801	151 (71.2)	9–97 (median: 67)	42 (19.8)
Moss SE, et al. (5)	Cross-sectional, population based	White, English	57 (1.2)	4747	NA	43–86	5 (9.0)
Mitchell P. et al. (6)	Cross-sectional, population based	Australian	36 (1.0)	3583	NA	>55	3 (8.3)
Han C, et al. (22)	Cross-sectional; population based	Asian, Chinese	26 (0.89)	2914	NA	NA	NA
Wright A D, et al. (23)	Cross-sectional, population based	White British/ other nations with DM	47 (30/17) (0.49)	9590	29 (61.70)	male: 46–95 (73.8 ± 11.3) female: 53–95 (72.7 ± 9.6)	NA
Van den Born LI., et al. (28)	Retrospective, cross-sectional population based	White, Netherlands With RP	4 (17)	24	NA	NA	1 (25)
Ikeda Y, et al. (29)	Retrospective, cross-sectional population based	Asian, Japanese with RP	10 (3.1)	320	2 (20)	44–73	4 (40)

AH – asteroid hyalosis, n – number, NA – not available, RP – retinitis pigmentosa, DM – diabetes mellitus (population based – badanie populacyjne)

Tab. I. Prevalence of asteroid hyalosis.
Tab. I. Częstość występowania bielenia skrzącego.

over 40 or 50 years old in all studies. Furthermore, the prevalence rate of ABs within vitreous increases significantly in the seventh and eighth decade of life. In the Blue Mountains Eye Study, the mean prevalence of AH was 1.0%, ranging from 0.2% in participants between 49–55 years of age to 2.1% in the group aged 75 to 97 years (6). In the Beaver Dam Study the mean prevalence of AH was 1.2%, ranging from 0.2% in persons at the age of 43–56 years to 2.9% in the group aged 75 to 86 years (5). There are only three case reports of juvenile (24, 25) and neonatal AH (26). Most patients develop ABs in one eye, but in 8–14% of individuals both eyes are affected (2, 3, 5, 6, 8). In the autopsy population, the prevalence of bilateral AH reached 19.8% (4). Except for the Korean study, which did not reveal gender bias in AH patients (2), in population-based cross-sectional observations, AH is more frequent in males (3–6). Because of unilateral prevalence and literature discrepancies, the notion on correlation between AH and systemic diseases evaluated among years is still disputable. Early reports suggested diabetes (3, 9, 10), hypercholesterolemia (2), hypertension (2, 3, 11), gout (12), hyperopia (3, 11), greater body mass index, higher alcohol consumption (5), and increased serum calcium levels (10). However, most of these findings were based on case series. New papers from last decade, describing population analyses, do not confirm the association between AH and diabetes, gout, hyperopia, increased serum calcium levels, smoking and alcohol consumption (2, 4, 6). In autopsy population, the association between AH and hypertension, atherosclerosis, posterior vitreous attachment and age-related macular degeneration was revealed (4). The Korean study found correlation between AH and stroke history and confirmed the significance of hypertension, serum triglyceride levels, and low-density lipoprotein levels (2). However, the Blue Mountain study confirmed correlation with age and male sex only (6). The Portuguese retrospective case series of 58 patients pointed out that the prevalence of age-related macular degeneration and diabetes is on the same level as in general population (8).

Leber Congenital Amaurosis

Leber congenital amaurosis is one of the most severe diseases in all early onset retinal dystrophies. In Borman study, AH seems to be more common with the autosomal recessive retinal dystrophy caused by mutations in the lecithin retinol acyltransferase (LRAT) gene (27). This rare mutation was found in 4 patients of group of 149 persons with Leber congenital amaurosis. Two patients (3 eyes) of four analysed (8 eyes) had asteroid hyalosis: 54-year-old female with bilateral asteroid hyalosis and 41-year-old male with asteroid hyalosis in the right eye. In this cohort, AH seems to be very frequent – it appears in 37.5% of the eyes with LRAT gene and in 1.0% of whole analysed group with Leber congenital amaurosis. Women with severe asteroid hyalosis in left eye underwent vitrectomy, but it did not improve their visual acuity. This is the first publication to discuss asteroid hyalosis among patients with Leber amaurosis.

Retinitis Pigmentosa

Retinitis pigmentosa (RP) is an inherited retinal degenerative disease caused by several gene mutations. The progressive loss of photoreceptors, mainly rods, leads to impaired night vision and a gradual loss of visual fields. First cases of asteroid hyalosis among retinitis pigmentosa were described in 1994 by van den Born. In a group of 24 persons, with preserved para-arteriolar retinal pigment epithelium, 4 had AH (17.0%) (28). Kieda described a group of 10 persons (2 men, 8 women) with asteroid hyalosis (3.1%), aged 44–73 (mean: 61) among 320 persons (639 eyes) with typical retinitis pigmentosa. Four of them (40.0%) had bilateral asteroid hyalosis, 4 (40.0%) in the left eye and 2 in the right eye. In two females, AH was severe and progressive. One of them, a 48-year-old woman, underwent the 3-port vitrectomy combined with phacoemulsification. Her visual acuity improved. Kieda speculates that the high prevalence of AH in RP can be caused by blood–retinal barrier disruption seen in patients with RP (29). In Galveia report, among 58 patients (66 eyes) with asteroid hyalosis only one (1.7%) had RP (8).

Surface Calcification

Intraocular lens (IOLs) calcification is widely reported in literature. Most of the cases deal with hydrophilic acrylic lenses. It is an uncommon problem with silicon lenses (30). In case of dystrophic calcification, both posterior and anterior surfaces of hydrophilic acrylic IOLs are affected, while only the posterior surface gets calcified in silicone lenses (30).

Since 2004, twenty six cases have been reported in the literature to describe the association between AH and dystrophic calcification of silicone IOLs (31–37) but only one case regarding hydrophilic acrylic IOL has been published throughout the same period (38). In case of silicone IOLs, the presence of asteroid hyalosis was confirmed in 23 persons (88.5%).

Stringham described 8 different designs of silicone IOLs which calcified (31). The most common are silicone plate lenses (12 cases) and 3-piece AMO SI-30 lenes (7 cases). Slit lamp microscopy revealed crust-like deposits on the posterior optic part of silicone IOLs only (31–37). According to energy dispersive x-ray spectroscopy of explanted IOLs, deposits consist of phosphate and calcium, in addition to carbon, oxygen, and silicone peaks. The structure of deposits is similar to the one of hydroxyapatite (31–34).

Dystrophic calcification occurs at different times following the IOL implantation and leads to light-scattering and low light transmittance. According to clinical data, patients with AH and silicone IOLs suffer from glare, foggy or cloudy vision or decrease of visual acuity due to the posterior capsule opacification. Neodymium: yttrium aluminum garnet (Nd: YAG Q-swich) laser capsulotomy can improve visual acuity, however it facilitates the contact between vitreous and posterior surface of silicone IOL and probably accelerate the IOL opacification (32). In some cases, silicon IOLs calcification was observed after uneventful phacoemulsification without posterior capsulotomy (37). Deposit removal from IOLs using the Nd: YAG Q-swich does not solve the problem of decreased visual acuity. ABs are rich in calcium and phosphate, so the deposits reaccumulate on the IOL surface (31–35). Only explanting silicone IOL and exchange for a non-silicone IOL can definitely improve visual acuity. Because of patients dissatisfaction, silicone lenses were explanted 9.21 $\pm$ 3.66 years after uneventful surgery in Stringham study (31), up to 5 years in most of other cases

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(32–34, 36) and 12 years after implantation in a case described by Fuchihata (37). In all cases, the explanation improved visual acuity.

Hydrophilic acrylic postoperative opacification has been one of the leading cause of IOLs explantation (30). However, they are thought to be safe, and in some way intended for AH. In 2005, Werner described a case of a 76-year-old woman with bilateral asteroid hyalosis, calcification in an eye with silicone IOL and no opacity on the acrylic lens in her fellow eye during the 6-year observation (32). Similarly, Stringham did not find any association between asteroid hyalosis and acrylic lenses (31). Recently, de Almeida has described the first case of hydrophilic acrylic lens dystrophic calcification in a patient with AH (38). It is an uncommon finding of an unknown mechanism which does not have any support in the literature.

Conclusion

Pathogenesis and etiology of asteroid hyalosis is not well-known. Except for age and male sex, the risk factors are disputable and not conclusively confirmed. Dense vitreous structure in eyes with asteroid hyalosis may lead to vitreoretinal diseases and complications during vitrectomy.

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