



## Is There an Association between Pseudoexfoliation and Sensorineural Hearing Loss? A Case Control Study

Authors

Dr Aamina Shah<sup>1</sup>, Dr Rameez Ganie<sup>2</sup>, Dr Athar Shah<sup>3</sup>, Dr Sabia Rasid<sup>4</sup>,

Dr Imtiyaz Dar<sup>5</sup>

<sup>1,4,5</sup>GMC Srinagar

<sup>2,3</sup>SKIMS MC Srinagar

### Abstract

**Purpose:** The purpose of this study was to study the presence of sensorineural hearing loss (SNHL) in patients with pseudoexfoliation (PXF) syndrome and its correlation with other ophthalmic findings.

**Methods:** A total of 55 patients with PXF and 50 age-matched and sex-matched normal controls were subjected to complete ophthalmological and audiological evaluation. The degree of hearing loss was compared between the two groups and correlated with pseudoexfoliation glaucoma. The independent-student t test, chi-square test, Fischer exact test Z test were used for statistical analysis.

**Results:** A total of 77 patients among 105 patients (73%) had sensorineural hearing loss with pseudoexfoliation patients accounting for 62% and controls for 38%. Among the pseudoexfoliation group, 7 had normal hearing threshold level, 42 had mild SNHL, 6 had severe SNHL, while in the control group 21 had normal hearing threshold levels, 26 had mild degree of SNHL, 2 had severe degree of SNHL and 1 patient had profound degree of SNHL. When the hearing thresholds in decibels were compared between the two groups at frequencies 250, 500, 1000 and 2000 Hz using pure tone audiometry, the difference was statistically significant at all frequencies. Further there was no significant difference between the hearing thresholds of patients that had pseudoexfoliation glaucoma and those that had pseudoexfoliation alone.

**Conclusion:** The prevalence and severity of SNHL increases in cases of PXF compared with age-matched controls. This is not affected by presence or absence of glaucoma. This confirms the systemic nature of the disease and may have an implication on the treatment of these patients with regards to communication during the treatment. Hence it may become important to screen these patients for sensorineural hearing loss.

**Keywords:** Pseudoexfoliation, sensorineural hearing loss, glaucoma.

### INTRODUCTION

Pseudoexfoliation (PXF) is a systemic condition related to the excessive production and deposition of abnormal fibrillar extracellular material, primarily affecting eye and visceral organs.<sup>1</sup> The hallmark of exfoliation syndrome is the appearance of whitish deposits and dandruff-like

flakes on the anterior capsule of the crystalline lens and on the pupillary margin. Flakes and granular globs may also appear in the trabecular meshwork, the corneal endothelium, the zonular fibers, the ciliary processes, or the anterior vitreous face. Exfoliative material has also been described in the conjunctiva, iris, orbit, orbital

vessels, retinal vessels, skin, and connective tissue portions of the heart, lungs, liver, gallbladder, kidney, and cerebral meninges.<sup>2-11</sup>

Exfoliation syndrome has been associated with glaucoma since first reported by Lindberg in 1917.<sup>12</sup> The association between pseudoexfoliation and sensorineural hearing loss has been demonstrated recently. The fact that tectorial and the basilar membranes of the inner ear, like the anterior segment structures of the eye, are derived from the neural ectoderm, has led to the hypothesis behind this association. Pseudoexfoliative material has been found on the tectorial and basilar membrane of the inner ear in some studies<sup>13</sup>. Hence accumulation of pseudoexfoliative material on these structures may lead to interference with normal hearing threshold levels due to dysfunction of the mechanoreceptors of the ear, resulting in hearing loss.

The American Speech Language Hearing Association defines normal hearing sensitivity as air conduction threshold of 20 dB HL or less in the frequencies 250, 500, 1000, 2000, 4000, and 8000 Hz.<sup>14</sup> The degree of hearing loss is considered mild if average air conduction threshold is 21–40 dB HL, moderate if average threshold is 40–61 dB HL, severe if average threshold is more than 61–80 dB HL and profound if average threshold is more than 80db.

Normal hearing threshold levels in humans are 0–20 dB, where dB (decibel) is the logarithmic unit of sound intensity which implies loudness of sound energy.<sup>15</sup> Hearing threshold of 21 dB or more in any one ear is considered as hearing impairment in that ear<sup>15</sup>. Sensorineural hearing loss (SNHL) is the most common form of human sensory deficit and accounts for approximately 70% of cases while encompassing various pathologies in both the inner ear and the auditory nerve<sup>16</sup>.

#### **PURPOSE**

The aim of this was to find out the association between pseudoexfoliation syndrome and

sensorineural hearing loss and their correlation with other ophthalmic findings.

#### **MATERIALS AND METHODS**

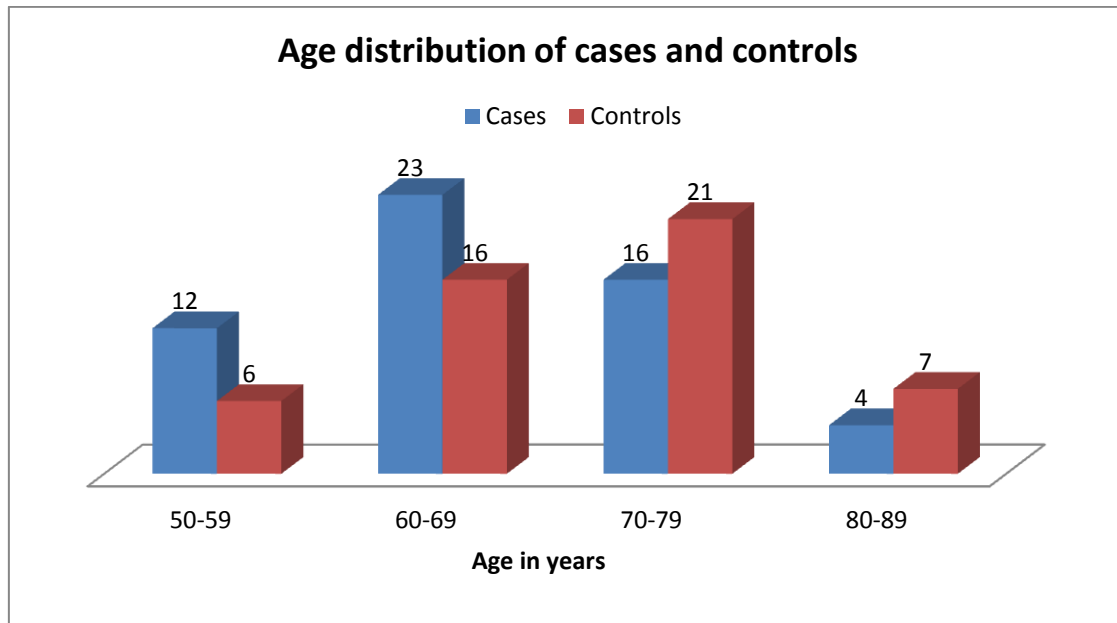
The study was conducted in the Department of Ophthalmology and Otorhinolaryngology, Government Medical College Srinagar, between June 2015 to Jan 2016. A group of 55 patients with pseudoexfoliation syndrome were compared with 50 age and gender matched controls. A complete medical and surgical history was recorded from patients in both the groups. Ophthalmic examination including slit lamp biomicroscopy, gonioscopy, applanation tonometry, pupil dilation, and fundus examination using 78 lens to document cup-disc ratio was done. Patients with exfoliative material on the lens capsule, papillary margin, or angle in either or both eyes were considered to have PXF. Automated visual field examination was carried out for patients with best-corrected visual acuity better than 6/60 using Humphrey Visual Field Analyzer. Patients were referred to the ENT clinic for complete otological examination. Hearing assessment was done using puretone audiometry.

Inclusion criteria for case group were male and female adults diagnosed with PXF syndrome or glaucoma in either eye, while the control group was patients without ocular pseudoexfoliation matched for age and gender. Exclusion criteria include patients with any other type of secondary glaucoma other than pseudoexfoliation glaucoma or any ocular or systemic condition having hearing or ear associations. Furthermore patients with history of ear infection, surgery, tympanic membrane perforation, exposure to ototoxic drugs or heavy noise, and upper respiratory tract infection during examination were excluded.

#### **RESULTS**

A total of 55 consecutive cases with pseudoexfoliation and 50 age- and gender-matched controls were registered for the purpose of the study. The mean age of cases was  $67.25 \pm$

7.53 years (range 55-86 years) while the mean age for the control group was  $69.82 \pm 8.19$  years (range 50-81 years). The difference was statistically insignificant. (t-value= 1.68, p=0.097)



Patients with PXF were most commonly found in the age group of 60–69. Among cases there were 38 males and 17 females; among controls, there were 37 males and 13 females. (z=0.56, p=0.577).

Thus cases and controls were matched for age and gender. A total of 15 patients (27%) among cases were having pseudoexfoliation glaucoma.

	IOP Right eye Mean $\pm$ SD	p-value	IOP Left eye Mean $\pm$ SD	p-value
Pseudoexfoliation glaucoma group (n=15)	17.73 $\pm$ 3.92	p=0.007	17.67 $\pm$ 4.35	p=0.015
Controls (n=50)	14.84 $\pm$ 3.39		14.94 $\pm$ 3.52	

Thus mean IOP was significantly higher in the pseudoexfoliation glaucoma group compared with

the control group ( $P = 0.007$  for right eye and  $P = 0.015$  for the left eye).

	IOP Right eye Mean $\pm$ SD	p-value	IOP Left eye Mean $\pm$ SD	p-value
Pseudoexfoliation group (n=55)	16.05 $\pm$ 4.20	p=0.110	15.94 $\pm$ 4.33	p=0.200
Controls (n=50)	14.84 $\pm$ 3.39		14.94 $\pm$ 3.52	

The mean IOP was not significantly different in pseudoexfoliation syndrome group vs control group. All patients with PXFG were receiving antiglaucoma medication.

Overall among 55 cases, 48 patients (87%) had varying degrees of sensorineural hearing loss while among controls 29 patients (58%) had sensorineural hearing loss.

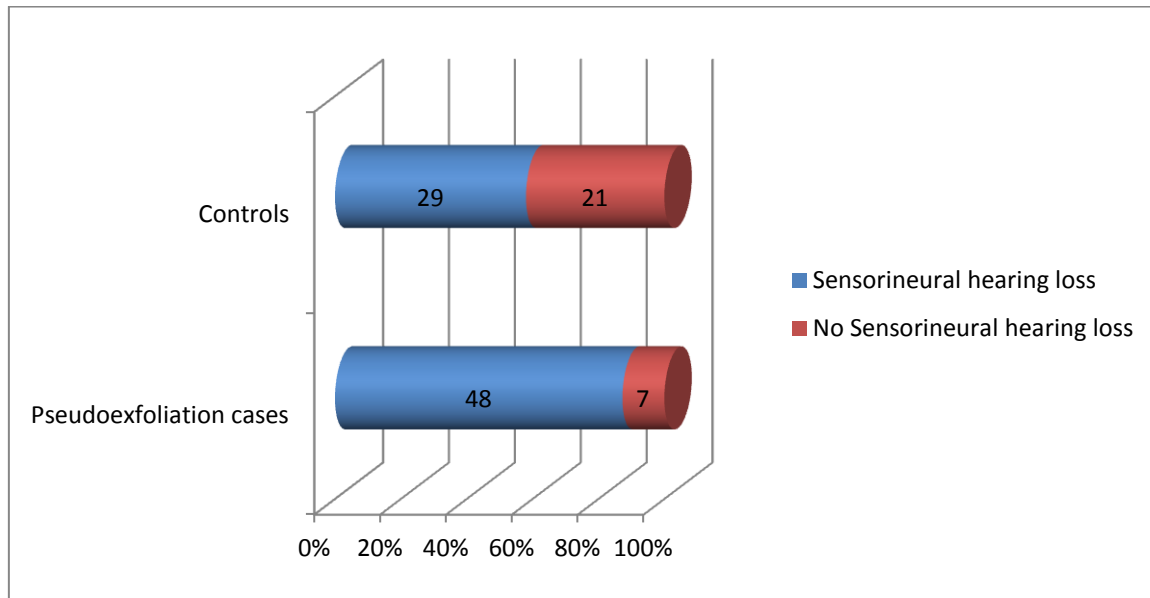
(Fisher’s exact test p=0.001)

Thus a total of 77 patients among 105 patients (73%) had sensorineural hearing loss with pseudoexfoliation patients accounting for 62% and controls for 38%.

Among 77 patients with sensorineural hearing loss, 58 were males and 19 were females.

$\chi^2=2.148$ , df=1, p=0.143

Among patients with pseudoexfoliation glaucoma (n=15), 13 (87%) had sensorineural hearing loss. Comparing this proportion with pseudoexfoliation syndrome group, the difference was not found statistically significant. (z=0.06, p=0.951).



Degree of hearing loss among pseudoexfoliation group and the control group.

Degree of hearing loss	Pseudoexfoliation group	Control group	Total
Normal (0-20dB)	7 (13%)	21 (42%)	28 (27%)
Mild (21-40)	42 (76%)	26 (52%)	68 (64%)
Moderate (41-60)	6 (11%)	2 (4%)	8 (8%)
Severe (61-80)	0 (0%)	1 (2%)	1 (1%)
Profound (>80)	0 (0%)	0 (0%)	0 (0%)

Hearing loss in right ear at each frequency in cases and controls

Frequency	Hearing loss in pseudoexfoliation group Mean±SD	Hearing loss in control group Mean±SD	t-stat	p value
250	30.85 ±7.32	23.46 ±12.75	3.68	0.000
500	29.31 ±8.20	23.66 ±13.53	2.61	0.010
1000	32.24 ±6.91	22.10 ±11.86	5.41	0.000
2000	33.87 ±7.75	22.7 ±12.54	5.54	0.000

Hearing loss in left ear at each frequency in cases and controls

Frequency	Hearing loss in pseudoexfoliation group Mean±SD	Hearing loss in control group Mean±SD	t-stat	p value
250	29.24 ±7.11	22.4 ±13.43	3.30	0.001
500	28.95 ±8.42	22.14±12.84	3.24	0.002
1000	32.10±7.36	23.45 ±12.54	4.36	0.000
2000	32.80 ±8.93	24.12±13.48	3.92	0.000

Thus upon comparing the hearing thresholds at frequencies of 250, 500, 1000, and 2000Hz

between the two groups, the difference came out to be statistically significant at all frequencies.

## DISCUSSION

In our study we studied the association between pseudoexfoliation syndrome and sensorineural hearing loss. The pseudoexfoliative material has been hypothesized to be deposited on the tectorial and basilar membrane of the inner ear in recent studies.<sup>13</sup> This might be cause of hampering of fine vibrations induced by sound waves thus limiting conversion of sound energy into neural impulses.

In this study we chose frequencies important for speech and hearing, viz 250Hz, 500Hz, 1000Hz, and 2000Hz, and tested each ear separately.

The pseudoexfoliation group and the control group were both age and gender matched. Among the 105 patients included in this study 73% had sensorineural hearing loss, of which pseudoexfoliation group accounted for 62% of cases and controls accounted for another 38%. A study done by Yazdani et al. also found that SNHL in pseudoexfoliation syndrome (PXF) patients was more common (88.4%) than in controls (53.6%)<sup>17</sup>.

In the pseudoexfoliation group 48 among 55 patients (87%) had varying degrees of sensorineural hearing loss while among controls 29 patients (58%) had sensorineural hearing loss. (Fisher's exact test  $p=0.001$ ). This is in agreement with the results of study conducted by Samarai *et al*<sup>[13]</sup>, who studied 50 patients with PXF (23 male patients with a mean age of 61 years, range 52–70 years, and 27 female patients with a mean age of 60.5 years, range 52–69 years). The results of this study showed that SNHL was more common in the study group with PXF compared with age-matched and sex-matched controls ( $P = 0.001$ ).

Further, in study we found that there was no statistically significant difference between patients with or without glaucoma as regards the degree of hearing loss. This is in agreement with the results of the Yazdani *et al.*<sup>17</sup>, who found that glaucoma was significantly more common in patients with PXF but was not associated with more hearing loss. Moreover, Samarai *et al.* compared the severity and prevalence of SNHL between PXF

patients and patients with concomitant PXF and glaucoma. The results demonstrated that the difference was not statistically significant ( $P = 0.118$  and  $0.193$ , respectively).<sup>18</sup>

## CONCLUSION

In this study we found that there was a significant association between pseudoexfoliation glaucoma and sensorineural hearing loss. Our study substantiates the fact that pseudoexfoliation syndrome is a systemic disease and has been found to involve other parts of the body like the skin, vascular structures, and visceral organs such as the kidney, heart, lungs, gall bladder, and the inner ear. Hence it may be imperative to screen all patients of pseudoexfoliation syndrome for hearing assessment as this may have a bearing on the communication during treatment of these patients and also there day to day activities.

## BIBLIOGRAPHY

1. Altintas O, yuksel N, Karabas VL, Qaglar Y. Diurnal intraocular pressure elevation in pseudoexfoliation syndrome. *Eur J Ophthalmol* 2004; 14 : 495-500.
2. Shakib M, Ashton N, Blach R: Electron microscopic study of pseudo exfoliation of the lens capsule. II. Iris and ciliary body. *Invest Ophthalmol* 1965; 4:154.
3. Ringvold A: Electron microscopy of the limbal conjunctiva in eyes with pseudo exfoliation syndrome (PE syndrome). *Virchows Archiv A Pathol Anat Histopathol (Berlin)* 1972; 355:275.
4. Speakman JS, Ghosh M: The conjunctiva in senile lens exfoliation. *Ophthalmology* 1976; 94:1757.
5. Ringvold A: Electron microscopy of the wall of iris vessels in eyes with and without exfoliation syndrome (pseudoexfoliation of the lens capsule). *Virchows Archiv A Pathol Anat Histopathol (Berlin)* 1969; 348:328.

6. Ghosh M, Speakman JS: The iris in senile exfoliation of the lens. *Can J Ophthalmol* 1974; 9:289.
7. Streeten BW, Dark AJ, Wallace RN, et al: Pseudoexfoliative fibrilopathy in the skin of patients with ocular pseudoexfoliation. *Am J Ophthalmol* 1990; 110:490.
8. Schlötzer Schrehardt U, Kühle M, Naumann GOH: Electron microscopic identification of pseudoexfoliation material in extrabulbar tissue. *Arch Ophthalmol* 1991; 109:565.
9. Schlötzer Schrehardt U, Koca MR, Naumann GOH, Volkholz H: Pseudoexfoliation syndrome. Ocular manifestation of a systemic disorder? *Arch Ophthalmol* 1992; 110:1752.
10. Streeten BW, Li ZY, Wallace RN, et al: Pseudoexfoliative fibrilopathy in visceral organs of a patient with pseudoexfoliation syndrome. *Arch Ophthalmol* 1992; 110:1757.
11. Amari F, Umihira J, Nohara M, et al: Electron microscopic immunohistochemistry of ocular and extraocular pseudoexfoliative material. *Exp Eye Res* 1997; 65:51.
12. Lindberg JGMD: Clinical studies of depigmentation of the pupillary margin and transillumination of the iris in cases of senile cataract and also in normal eyes of the aged [original in German]. Thesis, Diss Helsingfors, Finland, 1917.
13. D. J. Lim, "Functional structure of the organ of Corti: a review," *Hearing Research*, vol. 22, pp. 117–146, 1986.
14. Guidelines for audiologic screening. American Speech Language Hearing Association. c1997. Available at: <http://www.asha.org>. [Accessed 1 March 2013]
15. The American Speech and Hearing Association 1997–2010, "Facts about hearing assessment," [www.asha.org/public/hearing/testing/assess.htm](http://www.asha.org/public/hearing/testing/assess.htm)
16. N. Strenzke, D. Pauli-Magnus, A. Meyer, A. Brandt, H. Maier, and T. Moser, "Update on physiology and pathophysiology of the inner ear: pathomechanisms of sensorineural hearing loss," *HNO*, vol. 56, no. 1, pp. 27–36, 2008.
17. S. Yazdani, A. Tousi, M. Pakravan, and A.-R. Faghihi, "Sensorineural Hearing Loss in Pseudoexfoliation Syndrome," *Ophthalmology*, vol. 115, no. 3, pp. 425–429, 2008.
18. Samarai V, Samarei R, Haghighi NN, Jalili E. Sensory-neural hearing loss in pseudoexfoliation syndrome. *Int J Ophthalmol* 2012; 5:393–6.