In Situ Heavy Metal Deposition in the Human Eye

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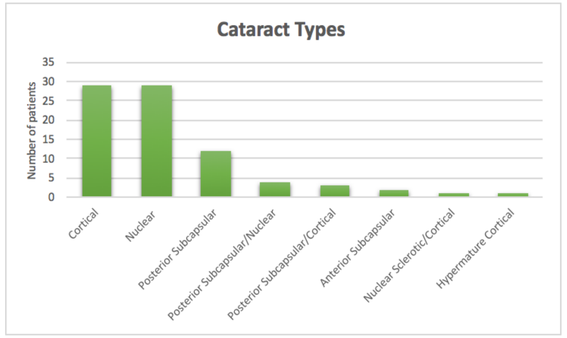
Introduction

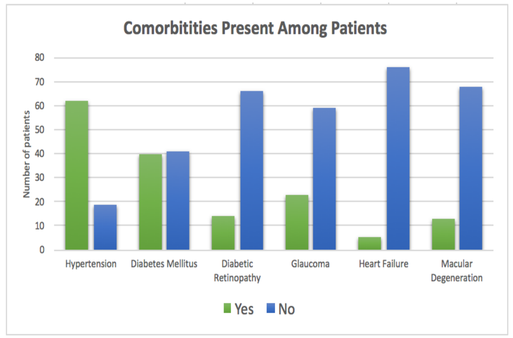
- Cataract, or clouding of the lens, is the leading form of reversible blindness worldwide. Cataracts have been associated with a multitude of diseases ranging from diabetes, glaucoma, and various other forms of retinal degeneration.
- The human eye is continuously exposed to the environment filled with heavy metal pollutants, leaving the eye susceptible to heavy metal toxicity. The role of heavy metals in the development of cataracts has yet to be fully determined.
- This study uses human tissue to determine ocular heavy metal levels in-situ as a way to generate hypotheses regarding relationships between heavy metal deposition in the eye and relevant eye and systemic disease.

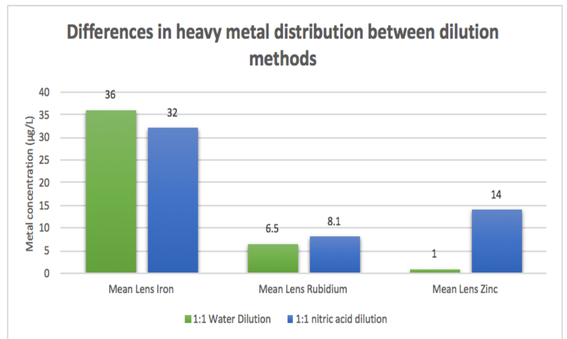
Methods

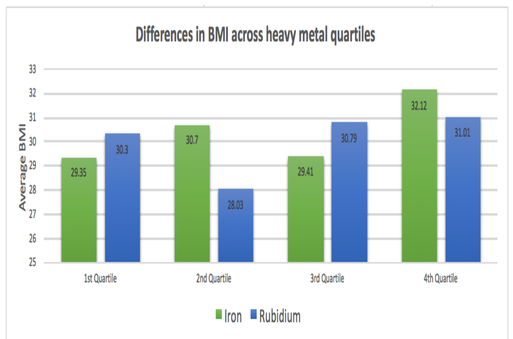
- Cross sectional analysis of lens specimens taken at the time of cataract surgery.
- Lens tissue (N=84) were subjected to a 1:1 dilution with both water and concentrated high purity nitric acid to be used for spectroscopy by Total Reflection X-Ray Fluorescence (TXRF).
- Relevant data such as concomitant diseases and patient demographics were collected from electronic records (EPIC).
- Using multivariate logistic regression, the relationship between heavy metal data and cataract type and concomitant disease was examined.

Results









	Mean	SD	Minimum	Maximum	Median	IQR
Lens Fe	32.68	66.23	.00	500.00	21	0 - 39
Lens Rb	6.71	5.74	.00	22.60	8.5	0 - 11
Lens Cu	.51	2.47	.00	19.10	0	0 - 0
Lens Zn	5.43	18.83	.00	114.00	0	0 - 0

Table 1. *Heavy metal demographics*

	OR (95% CI)	*p*
Heart Failure (N=81)		
Lens Fe	1.01 (1.00 – 1.01)	.10
Lens Rb	0.85 (0.70 – 1.04)	.12
Lens Zn	1.01 (0.97 – 1.05)	.63
Macular Degeneration (N=81)		
Lens Fe	0.99 (0.98 – 1.01)	.52
Lens Rb	1.00 (0.90 – 1.11)	.94
Lens Zn	1.02 (0.99 – 1.04)	.17

Table 2. *Effect of heavy metal concentrations on comorbidities*

	OR (95% CI)	*p*
Lens Fe *(Reference is Cortical)*		.68
Posterior Subcapsular	1.00 (0.98 – 1.01)	.53
Nuclear	1.00 (0.99 – 1.01)	.54
Lens Rb *(Reference is Cortical)*		.25
Posterior Subcapsular	1.07 (0/95 – 1.21)	.26
Nuclear	0.97 (0.88 – 1.06)	.48
Lens Zn *(Reference is Cortical)*		.10
Posterior Subcapsular	0.82 (0.49 – 1.36)	.44
Nuclear	0.99 (0.96 – 1.01)	.32

Table 3. *Effect of heavy metal concentrations on cataract type*

Note for Table 2 and Table 3:

- OR = 1: Exposure to metal does not affect odds of outcome (comorbidity or cataract type compared to cortical)
- OR > 1: Exposure to metal is associated with higher odds of outcome (comorbidity or cataract type compared to cortical)
- OR < 1: Exposure to metal is associated with lower odds of outcome (comorbidity or cataract type compared to cortical)
- Confidence interval measures precision of odds ratio

Results

- Zinc levels appear to show trends toward a protective action against posterior subcapsular cataract.
- Elevated lens rubidium appears to be associated with reduced risk of heart failure.
- Odds of finding zinc concentration in lens samples are statistically higher when using nitric acid dilution compared to water dilution *(p*=.03).

Conclusion

- Heavy metals are found in measurable quantities in the human lens and, in the case of zinc, may be associated with protective effects in terms of posterior subcapsular cataract.
- Further study is required to define the association between heavy metal deposition in the lens and various forms of ocular and systemic disease as noted by the interesting finding regarding lens rubidium and heart failure.
- Future studies should aim to include more samples as a way to adequately power the study and further reinforce the relationship between heavy metal deposition and ocular and systemic disease.

References

1. Erie JC, Butz JA, Good JA, Erie EA, Burrritt MF, Cameron JD. Heavy Metal Concentrations in Human Eyes. Am J Ophthalmol 2004; 139: 888-893.