Nanotechnology in ophthalmology

Dear Editor,

We applaud Katoch *et al*., on their study, "Structural sequelae and refractive outcome 1 year after laser treatment for type 1 prethreshold retinopathy of prematurity in Asian Indian eyes," through which they have contributed toward the fight against retinopathy of prematurity (ROP), one of the major causes of childhood blindness.[1]

ROP, first described by Terry in 1942 (term was coined by Heath in 1951), is a disease where normal vascular development is altered and abnormal neovascularization occurs, leading to distressing complications and sequelae, e.g. retinal detachment, macular dragging causing pseudostrabismus, amblyopia as a result of myopia, glaucoma, etc. The disease is classified according to the International Classification of Retinopathy of Prematurity (ICROP), wherein modifications like pre-plus disease, aggressive posterior ROP and prethreshold disease have been incorporated.[2]

Prevention is the best policy for ROP, and it requires identification of risk factors, patients at risk and to bring these patients under the screening blanket. Low birth weight and preterm birth are the most significant factors responsible, although others like oxygen supplementation, apnea, septicemia, hemmorhage, hypoxia, etc. are also known to contribute.

Traditional treatment for acute phase ROP has evolved from cryotherapy to laser photocoagulation to anti-vascular endothelial growth factor (anti-VEGF) therapy (currently under investigation). All these come with their share of virtues and vices. Laser has the advantages of less systemic morbidity, lesser dependence on general anesthesia, reduced incidence of refractive errors and shorter postoperative course for resolution, but is marred by factors like iatrogenic cataract, foveal burns, retinal detachments, etc. Anti-VEGF therapy is plagued by questions like long-term effect, systemic toxicity, etc.[3]

Tireless efforts to develop more-effective, less-destructive therapy for ROP have added a chapter called Nanotechnology, which includes biopharmaceuticals, e.g. drug delivery systems (DDS), drug discovery, implantable materials like tissue regeneration scaffolds, bioresorbable materials, implantable devices like intraocular pressure monitors, glaucoma drainage valves and diagnostic tools like genetic testing, imaging and intraocular pressure monitoring.[4]

Nanoparticles (NPs) are nanometer-scaled particles and can be used in the form of nanocapsules, nanoconjugates or NPs themselves for the treatment of not only retinopathy but also retinal degenerations, and uveitis. NPs overcome the limitations of current modalities and improve the bioavailability in the retina and the permeability of therapeutic molecules across the barriers. Molecules used are gold, silicate, silver, nanoceria, polylactic-co-glycolic acid (PLGA) chitosan, etc. Studies have shown that GoldNPs inhibit retinal neovascularization, angiogenesis and vascular permeability via suppression of VEGF receptor-2 activation. Nanocapsules with Flt23K plasmid also allow targeted gene delivery with intravenous administration and inhibit progression of pathologic angiogenesis.[5]

NPs like Nanoceria and lipid nanocapsules prevent light-induced retinal degenerations and apoptotic death of photoreceptor cells. NPs administered topically pass through the corneal barrier, exerting actions in the retinal layers. NPs encapsulating betamethasone and coated with tamoxifen have shown inhibitory effects on inflammation in cases of uveitis.[5]

Thus, Nanotechnology appears to have a bearing not only on ROP but also on most aspects of ophthalmology and, with advances, is expected to metamorphose into the keystone of treatment modalities in the future.

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Quick Response Code:	Website: www.ijo.in
	DOI: 10.4103/0301-4738.97557