

ORIGINAL RESEARCH

The association between myopia and glaucoma- A comprehensive review of evidence

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ABSTRACT

Purpose: This study aims to explore the potential association between myopia and glaucoma, two prevalent ocular conditions with significant implications for visual health. It discusses the epidemiological evidence, pathophysiological mechanisms, and potential risk factors linking myopia and glaucoma. The study seeks to provide a better understanding of the complex interplay between these ocular disorders and their implications for clinical management. **Place of study:** Regional Institute of Ophthalmology, Guwahati Medical College & Hospital, Assam. It has been done with informed consent from the patients attending outpatient department. **Duration of study:** 2.5 years, during the period of 1st July 2020 to 31st December 2022. **Introduction:** Myopia, also known as nearsightedness, is characterized by difficulty in focusing on distant objects due to excessive elongation of the eyeball. Glaucoma, on the other hand, is a group of progressive optic neuropathy characterized by damage to the optic nerve and visual field loss. **Aim of study:** to evaluate the relationship between myopia and glaucoma to determine whether myopia serves as a risk factor for glaucoma development and progression. **Materials and methodology:** the present study was done with 208 glaucoma patients attending outpatient department. Systemic, routine ocular examination and laboratory investigations were done in all cases. Refraction, applanation tonometry, slit lamp biomicroscopy, gonioscopy, disc and retina evaluation and visual field examination was performed. **Results and discussion:** Among 208 patients, 86 were found to have high myopia exceeding -6D. Out of 86, 22 were found to have early POAG changes and 16 with advanced disc changes and glaucomatous field defects. The age of the patients enrolled under the study was 40 years and above. Rest had ocular hypertension and retinal degenerative changes. There were no cases of juvenile glaucomas under this study. **Conclusion:** Our study suggests a plausible relationship between myopia and glaucoma, although the exact mechanisms underlying this association remain incompletely understood. Further research, including large-scale prospective studies is essential to establish a more definitive link between myopia and glaucoma to guide appropriate clinical interventions for at-risk individuals.

Keywords: High myopia, Glaucomas

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INTRODUCTION

Myopia is a type of refractive error that makes it difficult to see objects that are far away without optical correction. It can be induced by lens and corneal curvature or by other factors. Axially elongated eyes represent a major portion of all myopia cases. Axial elongation can affect the intraocular structure, such as the optic disc or macula, which are target sites for glaucomatous damage. [1]

A meta-analysis carried out by Holden et al. (2016), estimated a global prevalence of 1406 million individuals with myopia and about 163 million with high myopia. As per the increasing trend of myopia, a prediction of 50% of the world's population developing myopia by 2050 was made too. [1a]

The overall crude prevalence of myopia in India over last four decades is 7.5% (95% CI, 6.5–8.5%) in 5-15-year age group. The prevalence of myopia is 8.5% (95% CI, 7.1–9.9%) in urban and 6.1% (95% CI, 4.5–

7.7%) in rural children, with highest prevalence in urban 11-15-year age group [15.0% in last decade]. A significant increment in prevalence is noted in the last decade in rural children from 4.6% to 6.8%, reflecting changing rural environment. [1b]

AIM OF STUDY

To evaluate the relationship between myopia and glaucoma to determine whether myopia serves as a risk factor for glaucoma development and progression.

METHODS

208 glaucoma patients (especially POAG) attending outpatient department were enrolled. Systemic, routine ocular examination and laboratory investigations were done in all cases. Thorough refraction, applanation tonometry, slit lamp biomicroscopy, biometry, keratometry, gonioscopy, disc and retina evaluation and visual field examination was performed.

INCLUSION CRITERIA

- a) High myopia patients with refractive error more than -6D
- b) Age above 40 years
- c) Patients with early or advanced optic disc changes and visual field defects owing to glaucoma

EXCLUSION CRITERIA

- a) Neurological diseases leading to optic disc changes and visual field defects
- b) Pseudophakics or aphakics
- c) Juvenile glaucoma patients

RISK FACTORS FOR HIGH MYOPIA: [3]

1. Genetics: Family history plays a significant role in the development of high myopia. If one or both parents have high myopia, there is an increased likelihood that their children may develop it as well.
2. Age: Myopia often starts in childhood and progresses during the school-age years. The risk of high myopia increases as a child grows and continues to develop until their late teens or early twenties.
3. Excessive Near Work: Engaging in prolonged periods of near work, such as reading, writing, or using digital devices up close, has been suggested as a potential risk factor for myopia development. However, its specific role in high myopia is not fully understood.
4. Lack of Outdoor Time: Some studies suggest that spending more time outdoors during childhood may help reduce the risk of developing myopia, including high myopia. The exact reason for this protective effect is not clear, but it may be related to exposure to natural light.

5. Ethnicity: Certain ethnic groups, such as East Asians, have a higher prevalence of myopia, including high myopia, compared to other populations. This suggests a genetic component to the condition.
6. Environmental Factors: Environmental factors, such as urbanization and lifestyle changes, may contribute to the increasing prevalence of myopia worldwide.
7. Prenatal and Early Childhood Factors: Few factors during pregnancy and early childhood, such as low birth weight and premature birth, may be associated with an increased risk of myopia, including high myopia.
8. Inadequate Eye Care: Lack of regular eye examinations and proper eye care may lead to undetected or uncorrected myopia, which can worsen over time, potentially leading to high myopia.

It's important to note that having one or more of these risk factors does not guarantee the development of high myopia, and the condition is likely influenced by a combination of genetic and environmental factors.

POSSIBLE RELATION OF MYOPIA WITH GLAUCOMA[3]

1. Optic Nerve Damage: Glaucoma is a group of eye diseases characterized by damage to the optic nerve, often caused by increased intraocular pressure (IOP). In high myopia, the elongated shape of the eyeball can lead to stretching and thinning of the tissues in the back of the eye, including the optic nerve head. This elongation can make the optic nerve more vulnerable to damage and may increase the risk of glaucoma.
2. Narrow Angle Glaucoma: In some cases, high myopia can be associated with narrower angles in the eye's drainage system (the trabecular meshwork). Narrow angles can impede the outflow of aqueous humor, leading to increased IOP and a form of glaucoma known as narrow-angle glaucoma.
3. Other Factors: Myopia and glaucoma may share certain risk factors. For example, both conditions have genetic components, and a family history of myopia or glaucoma can increase an individual's risk of developing either condition.
4. Age: Myopia often starts in childhood and progresses during adolescence and early adulthood. Glaucoma, on the other hand, is more commonly associated with aging. As high myopes age, they may be at a higher risk of developing age-related glaucoma due to the cumulative effects of high myopia and other age-related changes in the eye.

High myopes should undergo regular eye examinations to monitor their eye health and detect any signs of glaucoma early on. Routine eye check-ups can help detect increased IOP or changes in the optic nerve,

which may prompt further evaluation and timely intervention if needed.

WORK UP

- A.** Diagnostic Criteria of POAG patients: The criteria adopted was based on the Beaver Dam Eye Study. [5]
- I.O.P. \geq 22 mm Hg by Applanation tonometry.
 - Glaucomatous cupping and pallor of the optic disc. The cup to disc ratio \geq 0.8 or a difference of \geq 0.2 in the involved eye.
 - Visual field defect typical of glaucoma.
 - A gonioscopically open angle.
- B.** Diagnostic criteria for High myopia: two categories are possible, i.e. non-pathological and pathological myopia. [3]
- The degree of non-pathologic myopia is usually minimal to moderate ($<$ 6.00 diopters) and onset usually begins during childhood or adolescence.
 - Pathologic myopia is generally classified as a high myopic refractive error that is progressive and generally presents very early in childhood. Pathologic myopia is usually defined as spherical equivalent $>$ 6.00 diopters or axial length $>$ 26.5mm.

HISTORY

1. Informed consent from the patient.
2. Chief complaints with their durations were noted- blurred distance vision, deviated eyeballs while viewing distance objects, sitting closer to the television and computer or holding reading material closer.
3. History of anti- glaucoma medications, their dosage, duration and side effects noted.
4. Any systemic medications
5. Surgical treatment for glaucoma, if any, enquired.

PHYSICAL EXAMINATION

1. General physical examination: including consciousness, orientation, pallor, icterus, cyanosis, clubbing, lymphadenopathy, edema, PR, BP, RR measurement.
2. Systemic examination including CVS, Respiratory System, CNS, Per abdominal examination.

LABORATORY INVESTIGATIONS

1. Routine blood investigations
2. Fasting and post- prandial blood sugar, HbA1c levels.

3. Urine sugar level
4. Fasting lipid profile were done.

OPHTHALMIC EXAMINATION

- a) Visual acuity was recorded using a Snellen's chart. Cycloplegic correction checked.
- b) Ocular adnexa were examined.
- c) Slit lamp biomicroscopic evaluation was done:
 - Cornea: any opacities, abnormalities in contour, corneal diameter, oedema.
 - Anterior chamber: reaction, central and peripheral depth (Van Herrick's method)
 - Pupils: size, shape, border, pupillary reaction to light, exfoliation, ectropionuveae, etc. noted.
 - Iris: any changes like atrophy, iridectomy, rubeosis, heterochromia, granuloma, etc. noted.
 - Lens: lenticular opacities, position of lens.
- d) Goldman Applanation tonometry: to record corrected IOP. Three readings were taken in each eye and the mean value was used.
- e) Gonioscopy: by Goldman 3 Mirror Contact lens. The Shaffer's classification and Van Herick's grading was used to grade the angle of anterior chamber. He suggested using the angular width of the recess as the criterion for grading and attempted to correlate this with the potential for angle closure.
- f) Biometry and Keratometry were done.
- g) Dilated fundus examination: with Direct ophthalmoscopy, +90 D and I.O.
- h) OCT changes were noted- foveal macular thickness and retinal nerve fibre layer.
- i) Visual field changes were noted using Humphrey's Field Analyser.

STATISTICAL ANALYSIS

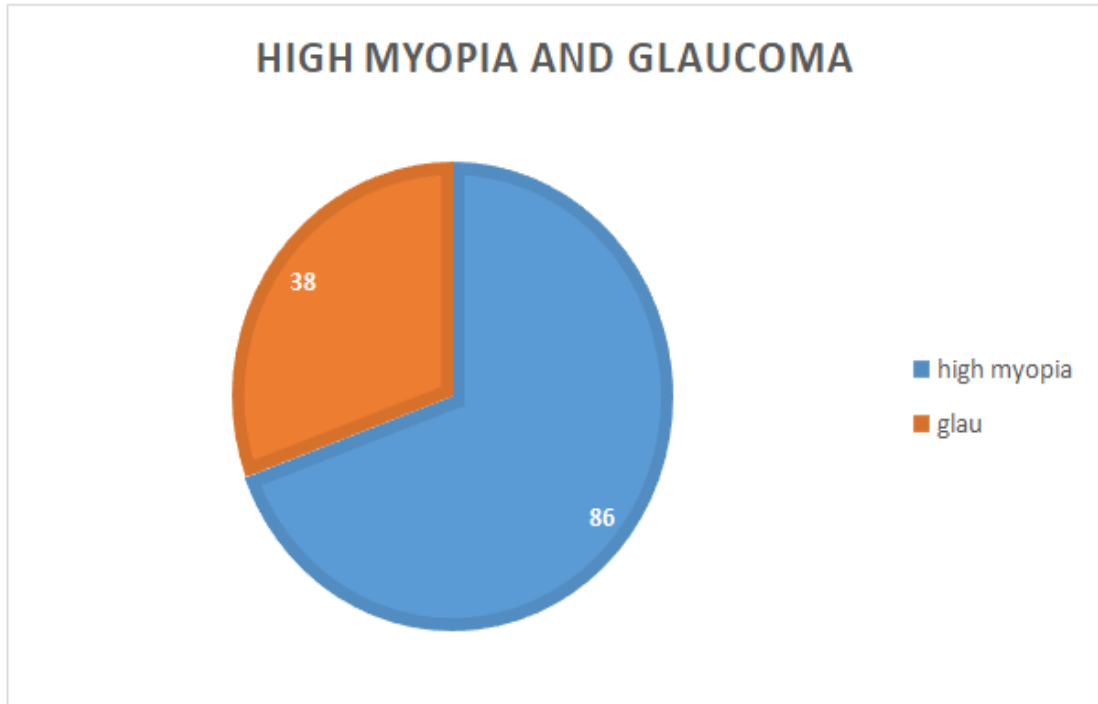
The data were assessed using a paired t-test. A p-value of less than 0.05 was considered to be statistically significant.

RESULTS

Among 208 patients, 86(41%) were found to have high myopia exceeding -6D. Out of 86, 22(R value= 0.068 and p value=0.038) were found to have early POAG changes and 16 (R value= 0.021 and p value= 0.063) with advanced disc changes and glaucomatous field defects. 8 patients had narrow angles. 111 were males and 97 were females. 116 patients had raised intraocular pressure on first visit. Rest had normal IOP and myopic retinal degenerative changes. 33 patients could not be followed up regularly in these 2.5 years. 12 did not report after two visits.

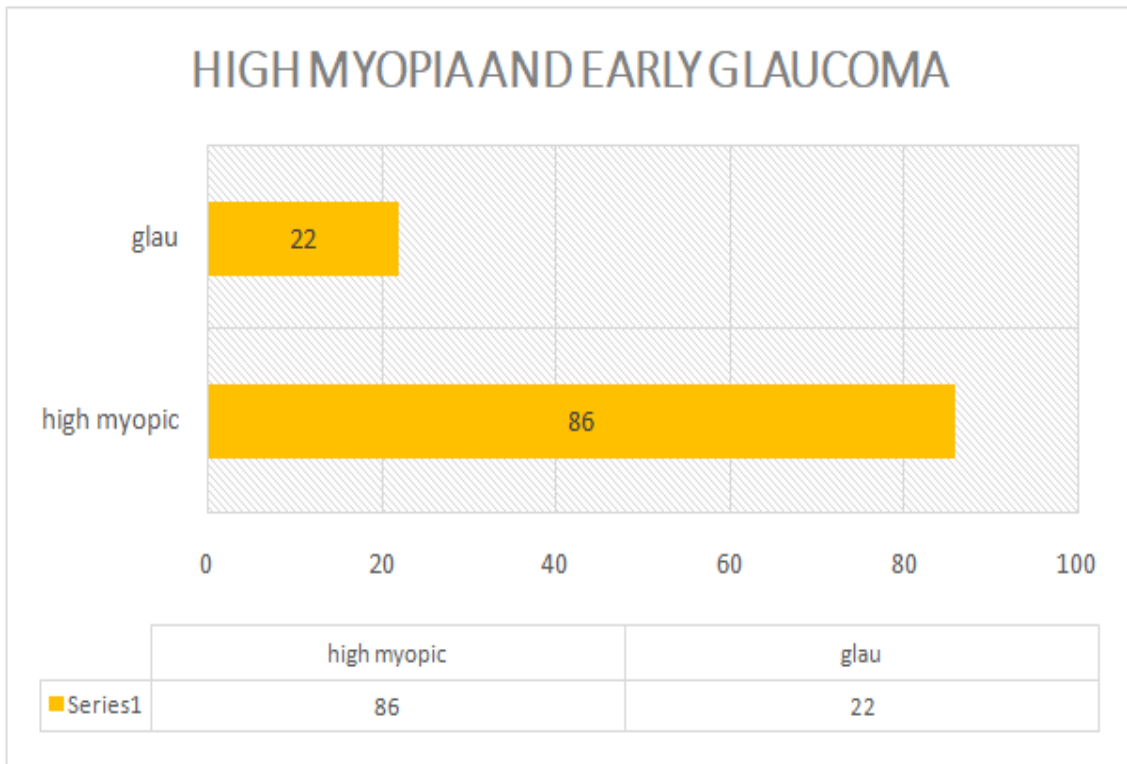
RELATION BETWEEN HIGH MYOPIA AND GLAUCOMATOUS DISC CHANGES

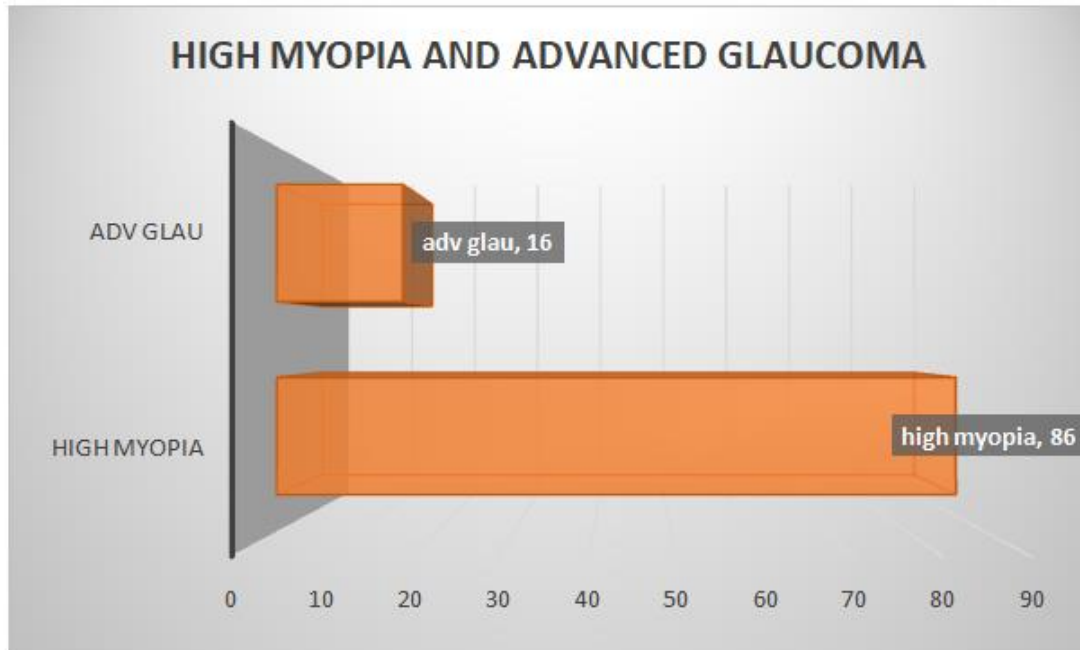
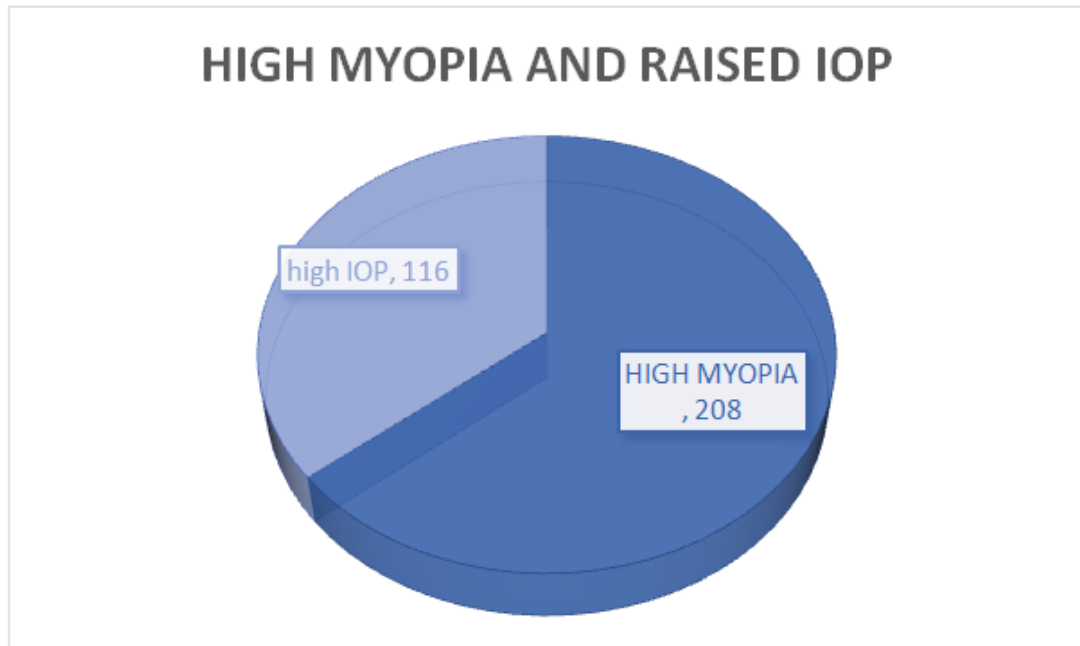
Chart 1:



RELATION BETWEEN HIGH MYOPIA ANDEARLY GLAUCOMATOUS DISC CHANGES

Chart 2:



RELATION BETWEEN HIGH MYOPIA AND ADVANCED GLAUCOMA**Chart 3:****RELATION BETWEEN HIGH MYOPIA AND RAISED IOP****Chart 4:****DISCUSSION**

- **The present study** shows a positive relation between high myopia and glaucoma. (p -value < 0.05) However, there is no relation on the progression of glaucoma with myopia.
- **Xu et al. (2007)** found that marked to high myopia exceeding -6 diopters was associated with a high prevalence of glaucomatous optic neuropathy. [2]
- **Mitchell P, et al. (2010-15)** did a population-based study where it was found that the risk of glaucoma increases with the increasing degree of myopia. [4]
- **The Blue Mountains Eye Study 1999**, when discussing the association between myopia and glaucoma, after adjusting for age, sex, and other risk factors, found a strong relationship between POAG and myopia, with an odds ratio of 2.3 in eyes with low myopia (between -1.0 and -3.0D) and 3.3 in eyes with moderate-to-high myopia (>-3.0D) [4]

- In the **Barbados Eye Study 1996**, a myopia was one of several risk factors for POAG in adult black people [5].
- **The Beaver Dam Eye Study 1994** showed that, after taking into account the effects of age, sex, and other risk factors, persons with myopia were 60% more likely to have glaucoma than those with emmetropia [6].
- **The Singapore Malays Eye Study, 2010** showed an association between moderate or high myopia (worse than -4 D) and POAG. Persons with moderate or high myopia had an almost 3 times higher risk of POAG compared with those with emmetropia [7].
- In **Beijing Eye Study in China in 2007**, a population study, found that high myopia exceeding -6 D may be a risk factor associated with glaucomatous optic neuropathy [8].
- **Bhattarai S, et al (2012)** in their study found 63.3% (38) male and 36.7% (22) female out of 60 patients of POAG with mean age 54.4±15.4 years. Among them, 27 (45.0%) patients had diabetes mellitus or high myopia. Onset of POAG was found to occur after 11.1±8.3 years of the diagnosis of diabetes and 10.6±3.2 years after the diagnosis of high myopia. Therefore, the incidence of diabetes mellitus and high myopia was high and significantly associated in primary open angle glaucoma. POAG was detected soon after the onset of diabetes mellitus and high myopia. [9]
- Highly myopic eyes have a tendency to show a tilted optic disc with large optic disc/RNFL change may mimic the glaucomatous optic disc/RNFL peripapillary atrophy, which makes it difficult to assess glaucomatous neuroretinal rim changes. Hence, when adopting optic disc or RNFL change as a criterion for glaucoma progression, prevalence of glaucoma progression may appear to be low because the detection rate is low. [10]
- A myopic appearance. Therefore, myopic eyes that show a glaucomatous optic disc appearance may not be true glaucoma cases. [10]
- Biomechanical hypothesis proposes that the structural changes in the elongated eyeball of myopic individuals could lead to alterations in intraocular pressure and optic nerve head morphology, potentially increasing susceptibility to glaucomatous damage. [11]
- Myopia has been associated with changes in ocular blood flow and vascular abnormalities. It is hypothesized that compromised blood flow may contribute to glaucoma pathogenesis in myopic eyes. [11]
- Genetic susceptibility is also implicated. Along with that, excessive near work and less outdoor activities. [11]
- The foveal thickness, choroidal volume and the choroidal vessel volume had a significant increment with higher degrees of myopia. [12]
- Subfoveal choroidal thickness had significant positive correlation with refractive error and negative correlation with axial length. [13]
- Emmetropic eye (91.26 μ) had higher RNFL thickness compared to moderate (83.76 μ) and high myopic eyes (78.68 μ). [14]
- Low and moderate myopes had thinner fovea compared to high myopes. 2. The axial length had a positive correlation with the fovea minimum, fovea and superior inner macular thickness. [15]

CONFLICT OF INTEREST

None declared

ETHICAL CLEARANCE

Taken

SOURCE OF FUNDING

None declared

DECLARATIONS

(1) The article is original with the author(s) and does not violate any right of any third parties; (2) The article has not been published (whole or in part) elsewhere, and is not being considered for publication elsewhere in any form, except as provided herein; (3) All author(s) have contributed sufficiently in the article to take public responsibility for it and (4) All author(s) have viewed the final version of the above manuscript and approve it for publication.

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