

American Journal of Health, Medicine and Nursing Practice (AJHMN)



Correlation Between Central Corneal Thickness and Intraocular Pressure with the Goldmann Applanation Tonometer

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Correlation Between Central Corneal Thickness and Intraocular Pressure with the Goldmann Applanation Tonometer

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Article history

Submitted 24.11.2023 Revised Version Received 30.11.2023 Accepted 13.12.2023

Abstract

Purpose: The aim of this review is to investigate the correlation between central corneal thickness (CCT) and Intraocular pressure with the Goldmann applanation tonometer (GAT).

Materials and Methods: A literature search using Medline database was conducted for the years 1946 to 2022 to explore the relationship between central corneal thickness and Intraocular pressure measured by the Goldmann applanation tonometer. The search was restricted to studies published in English language. The first 80 articles were reviewed and five relevant studies were selected in this analysis.

Findings: Impacts of central corneal thickness on Intraocular pressure were investigated in five

studies. Overestimation of intraocular pressure is associated with thick cornea while underestimation of intraocular pressure was associated with thin cornea

Implications to Theory, Practice and Policy: Central corneal thickness can affect the result of Intraocular pressure measurement with the Goldmann applanation tonometer (GAT). Assessment of central corneal thickness (CCT) is necessary for correct interpretation of IOP measurements obtained with the Goldmann applanation tonometer (GAT).

Keywords: *Central Corneal Thickness, Intraocular Pressure, Relationship, Goldmann Applanation Tonometer*

1.0 INTRODUCTION

The Goldmann applanation tonometer (GAT) is based on the Imbert-Fick law which states that the pressure inside a sphere is equal to the force required to flatten its surface divided by the area of flattening. However, corneal resistance and capillary attraction of the tear film can affect this measurement. When the device applanates a circle with a diameter of 3.06 mm, capillary attraction and corneal thickness would cancel each other (assuming CCT is 520 μm) and the applanation pressure equals the intraocular pressure (1). Since its development in 1950, the Goldmann applanation tonometer has been acknowledged as the gold standard for measuring IOP (2). The GAT design assumes an average corneal thickness value of 520 μm , so the measured net IOP would be affected if the CCT deviated from this standard value (3). The purpose of this review is to examine the relationship between intraocular pressure measured by Goldmann applanation tonometer (GAT) and central corneal thickness (CCT).

2.0 MATERIALS AND METHODS

A literature search using Medline database for the years 1946 to 2022 was undertaken to explore the correlation between central corneal thickness and Intraocular pressure with the Goldmann applanation tonometer (GAT). The following keywords were used: central corneal thickness, Intraocular pressure, relationship, Goldmann applanation tonometer. The search was restricted to articles published in English language. The first 80 articles were reviewed and five relevant studies were selected in this article.

3.0 FINDINGS

Five studies examined the relationship between central corneal thickness (CCT) and Intraocular pressure with the Goldmann applanation tonometer (GAT) (4-8). One study assessed the relationship between central corneal thickness and the error of applanation tonometry. Thin corneas produced underestimation of the intraocular pressure by as much as 4.9 mm Hg, whereas thick corneas produced overestimations by as much as 6.8 mm Hg (4). Corneal thickness measurement is essential for correct interpretation of Goldmann applanation tonometry results, especially in eyes with thin corneas (4). Another study evaluated the intraocular pressure (IOP) measurements of Goldmann applanation tonometer in eyes with normal corneas of different thicknesses (5). Eyes with thicker corneas than normal, may have IOP overestimated (5). Similarly, eyes with thinner than average corneas may have IOP underestimated (5).

A study assessed the influence of corneal thickness on intraocular pressure (IOP) measurements obtained with a Goldmann applanation tonometer (GAT) in 230 eyes of 115 subjects (6). Result revealed that GAT and corneal thickness showed a significant positive correlation (6). The relationship between Intraocular pressure, Goldmann applanation tension, corneal thickness, and corneal curvature in Caucasians, Asians, Hispanics, and African Americans was evaluated in Observational retrospective cross-sectional study (7). African Americans had thinner central corneal thickness than Caucasians, Asians, or Hispanics (7). Uncorrected IOP measurements of African Americans may lead to delay in diagnosis of glaucoma (7). Goldmann applanation tonometry needs to be corrected by central corneal thickness and corneal curvature for proper diagnosis and management of glaucoma (7).

Furthermore, Photorefractive keratectomy (PRK) can cause changing of the Goldmann tonometer readings (8). Intraocular pressure (IOP) of 111 patients was measured by Goldmann applanation

tonometry at baseline and 12 months after PRK and contralateral eyes were used as controls (8). Corneal thickness measurements and keratometry were also obtained using ultrasound (8). Mean tonometer readings were statistically significantly reduced in treated eyes compared to control eyes, accompanied by a significant decrease in mean pachymetry in treated eyes (8). While a reduction in IOP measurement is mild and probably not enough to alter a therapeutic decision in an individual patient known to have glaucoma, but it may delay recognition and treatment of glaucoma (8).

Discussion

There is a good number of evidences revealed the effects of central corneal thickness (CCT) on Intraocular pressure measured with the Goldmann applanation tonometer (GAT) (4-8). Overestimation or underestimation of IOP in people with thick or thin cornea can affect the management of glaucoma. This review suggests that assessment of central corneal thickness (CCT) is necessary to interpret properly the measurements of Intraocular pressure with the Goldmann applanation tonometer (GAT).

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