



# Intraocular pressure fluctuation before and after strabismus surgery: a systematic review

Aliakbar Saber Moghaddam (MD)<sup>1</sup>, Mahdi Hashemi (MD)<sup>2\*</sup>, Ramin Daneshvar (MD)<sup>2</sup>

<sup>1</sup>Eye Research Center, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran.

<sup>2</sup>Cornea Research Center, School of Medicine, Mashhad University of Medical Science, Mashhad, Iran.

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### ABSTRACT

**Introduction:** Intraocular pressure (IOP) can be influenced by several factors including corneal thickness, gender, refractive error, and the presence of diabetes mellitus. In the present study, we systematically reviewed published literature to find association between variations of IOP due to strabismus surgery.

**Method:** PubMed and Scopus were systematically searched with the following search terms: (intraocular pressure OR IOP) AND (strabismus) for the articles in which the fluctuation of IOP before and after strabismus surgery had been evaluated. All types of articles including case series, cross-sectional, clinical trials, and cohort studies with no time limitation were included in this study. Systematically searches, selection of articles, and the extraction of data were performed by two reviewers independently.

**Result:** 1617 out of 1674 articles were excluded due to duplication or irrelevancy. After step by step process of article selection, 57 relevant articles were included for further evaluation. However, only 8 articles met the inclusion criteria.

**Conclusions:** The results of this report showed that IOP may vary due to strabismus surgery, and it decreases after the surgery.

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## Introduction

Strabismus, generally known as crossed eyes, is defined as an abnormal ocular alignment or any deviation in the direction of one or both eyes that may be congenital or acquired, horizontal, vertical, rotational, or combination of these modes (1). The deviation is expressed in degrees or prism diopters and have different etiologies. The most important and visible sign of strabismus is double vision and misalignment of the eyes, in which one eye turn in, out, up, down, or the eyes may be positioned obliquely. Strabismus may occur due to neurological or anatomical problems that interfere with the normal control and function of the muscles.

Intraocular pressure (IOP), generally known as eye pressure, is considered as the most important medical factors in ophthalmology, which can typically show the normal function of the eyes. The positive pressure within the eye is the result of balance between the production of aqueous humor by the ciliary process and outflow of aqueous humor from the trabecular meshwork and uveoscleral pathway, which is expressed in millimeters of mercury (mmHg). Moreover, different baseline values have been reported for IOP in different studies, but normal level of intraocular pressure (IOP) in 95% of the population (general population) is 10 to 21

**\*Corresponding author:** Mahdi Hashemi.

Cornea Research Center, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran.

**E-mail:** mahdi.hashemi1380@yahoo.com

**Tel:** 09132295390

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mmHg (mean 15.5 mmHg) with a small variation (2). Many factors such as corneal thickness, gender, refractive error, and the presence of diabetes mellitus (DM) influence the IOP (3,4), and among these factors, external pressure on the globe and the orbital contents are of great importance (5). In addition, it is shown that some anesthetics and chemicals such as nitrous oxide may change IOP and there may be some diurnal and seasonal variation of IOP (6). Extraocular muscle tone are very important in IOP measurement. IOP changes have been reported following the histopathological abnormalities or various manipulations of extraocular muscles such as botulinum toxin injections or side effects of medications (7-9). There are evidences that confirm the fluctuation of IOP following strabismus surgery (2,10,11). Finding an association between IOP changes and strabismus surgery is of great interest, because IOP changes can be considered as an indicator for restrictive strabismus if this assumption is proven (12,13).

There is a few studies in this field and a trustful and thorough methodology has not been used in these studies. Hence, a comprehensive study is necessary to show the effect of extraocular muscle surgery on IOP. Thus, the main aim of this study is to systematically review the effects of strabismus surgery on variations of IOP, and to find out whether IOP changes during or after strabismus surgery reflex, and malpositioning of the ETT.

## Methods

### Literature search strategy

PubMed and Scopus were searched thoroughly for articles in which the fluctuation of IOP before and after strabismus surgery had been evaluated. Both database were searched for IOP and strabismus in the title, keywords, and abstract. Relevant articles with the following search terms: (Intraocular pressure OR IOP) AND (strabismus) were selected and reviewed by two independent reviewers with the last update on February 2015. Irrelevant articles were omitted in the first step by reviewing the titles and abstracts of all collected records. Afterwards, the full texts of the relevant papers were studied. Finally, the reference lists of relevant articles were also searched manually to minimize the possibility of missing relevant articles.

### Study selection

There was no time limitation for the included articles. Articles in languages other than English were excluded to avoid problems during data extraction. All types of articles including case series, cross-sectional, clinical trials, and cohort studies were selected and included in this study. Review articles or previous meta-analysis were excluded.

Inclusion criteria were articles in which the studied patients had undergone strabismus surgery and the IOP were measured pre- and postoperatively. Because two independent database were searched, duplicated articles were omitted in the first step. Exclusion criteria were the articles in which the fluctuation of IOP was due to anatomical problems other than strabismus, inflammation of the eye, genetic factors, or medication- related side effects.

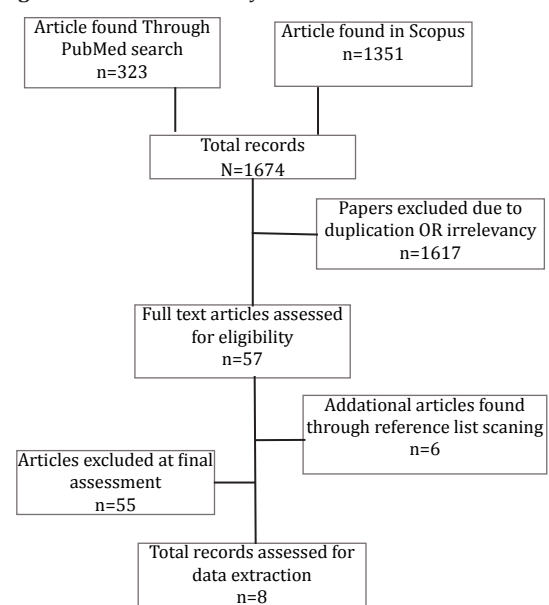
### Data extraction

Data including the name of first author, country of origin, publication date, study design, IOP before and after surgery and the concluded results were extracted. All available documents including total number of participants, demographic data and collected results were obtained as possible. Data were categorized based on the results recorded before and after surgery. The quality assessment of articles selected for this systematic review was performed according to the recommendations of CONSORT checklist 2010 by two independent reviewers (14).

## Results

Over 323 articles were found in PubMed and about 1351 articles in Scopus, 1617 were excluded due to duplication or irrelevancy. After step by step process of article selection in the two database, 57 relevant articles were included for further evaluation. Finally, full text of 8 articles, which met the inclusion criteria were obtained and data were collected. Articles that met the inclusion criteria were ultimately excluded if their full texts or even abstracts were not found. Step by step selection process is shown in Figure 1.

Figure 1. Flowchart of study selection



Data were extracted and analyzed statistically. The total number of patients in the selected literature that studied the relationship between the variation of intraocular pressure and strabismus surgery were 152 (220 eyes) with mean age of 36.41 years old. The age of the patients varied from six-month neonate to patient with 76 years of age. Among the studied population, there were 54 male and 92 female. In one study with 6 patients, gender had not been mentioned. Considerably, most of the studies have been conducted on females and on patients younger than 18 years of age. Number of participants also varied from 6 patients (11) to

40 participants in included studies (15).

Of these records, significant reduction of IOP from baseline has been reported in 7 studies, and only one study (5 eyes) reported marked increase in IOP during strabismus surgery. Of 220 operated eyes, almost all had IOP between 16 and 21 mmHg before surgery. However, the fluctuation varied from 0.9 mmHg to more than 59 mmHg after strabismus surgery. Analysis of data showed that IOP decreased due to strabismus surgery, and only small data showed the increase of IOP after surgery (Table 1).

**Table 1.** Characteristics of articles included in this study

Author Year Reference	Country	Study design	Number of patients	Study population	Mean IOP <sup>1</sup> changes before and after surgery
<b>Yoo 2010 (16)</b>	Korea	PS <sup>2</sup>	60 eyes of 31 patients	Female= 22 Male = 9	-5.5 (BS <sup>3</sup> : 16.3, AS <sup>4</sup> : 10.8)
<b>Gomi 2007 (17)</b>	USA	ROS <sup>5</sup>	29 eyes of 17 patients	Female= 13 Male = 4	-0.9 (BS: 16.6, AS: 15.7)
<b>Danesh-Meyer 20001 (10)</b>	USA	RCS <sup>6</sup>	32 eyes of 24 patients	Female= 22 Male = 2	-2.4 (BS: 18.5, AS: 16.1)
<b>Snir 1999 (18)</b>	Israel	PS	34 eyes of 20 patients	Female= 8 Male = 12	-8.26 (BS: 14.4, AS: 6.2)
<b>Kwitko 1992 (19)</b>	USA	PS	11 eyes of 7 patients	Female= 4 Male = 3	-9.5 (BS: 28.7, AS: 19.2)
<b>Pe'er 1986 (15)</b>	Israel	ROS	37 eyes of 40 patients	Female= 18 Male = 22	-9 (BS: 14.8, AS: 5.8)
<b>Hayashi 2014 (20)</b>	Japan	ROS	8 eyes of 7 patients	Female= 5 Male = 2	-5.6 (BS: 19.4, AS: 13.8)
<b>Raizman 1986 (11)</b>	USA	ROS	9 eyes of 6 patients	Female= NM <sup>7</sup> Male = NM	+ 59.5 (BS: 20.5, AS: 80)

<sup>1</sup>IOP: Intraocular pressure; <sup>2</sup>PS: Prospective study; <sup>3</sup>BS: Before surgery; <sup>4</sup>AS: After surgery; <sup>5</sup>ROS: Retrospective observational study; <sup>6</sup>RCS: Retrospective case study; <sup>7</sup>NM: Not mentioned

## Discussion

Association between strabismus surgery and variation of IOP is a disputed issue. IOP changes due to several external factors such as manipulation of eyes has been reported in some studies, but exact relationship between these variables is controversial. Studies showed that abnormal orbital anat-

omy might be responsible for fluctuation of IOP (20). Furthermore, it is shown that the IOP is often high in highly myopic strabismus patients, and it is suggested that surgery could improve both the eye position and IOP. This systematic review is a comprehensive study of its type with updated informa-

information about association between strabismus surgery and fluctuation of intraocular pressure. the airway and lead to the incidence of post-operative respiratory complications (12).

According to the extracted data and based on the results of included articles, strabismus surgery results in a significant reduction in IOP, especially in early period after surgery (20). Several reports have shown that IOP changes related to the muscle resection could be treated with some medications such as steroids, dexamethasone, and diclofenac, reflecting the effect of surgery on IOP (21-23). These drugs often act by controlling inflammation and discomfort in the eyes, which shows that IOP changes might be the result of pressure on the eye and surrounding tissues during surgery.

On the other hand, these data might not reflect the actual correlation between IOP changes and surgical intervention due to limited number of data in the field, inappropriate design of studies, limited number of participants, and inaccuracy of methods designed for the measurement of IOP during studies. Although, several reports showed that IOP significantly increased from baseline several days after surgery (18), some studies concluded that there might be no direct correlation between the pressure changes and strabismus surgery. Moreover, temporary increase in IOP might be due to the intensity of massage of globe during surgery (15).

## Conclusion

In sum, variation of intraocular pressure due to muscle recession is confirmed according to the extracted data; nonetheless, the changes might vary from very slight amounts to very high values. However, intraocular pressure reduces post-operatively at least for a few days after surgery according to reports.

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## Conflict of Interest

The authors declare no conflict of interest.

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