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Intraocular Pressure (IOP) Changes Secondary to Orbital Floor Reconstruction after Tumor Resection or Orbital Floor Fractures (A Clinical Study)

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ABSTRACT

An increase in intraocular pressure (IOP) is important in the mechanism of blindness. Ocular hypertension is a term that is used to describe individuals who is glaucoma suspect. High pressure inside the eye is caused by an imbalance in the production and drainage of fluid in the eye. The intraocular pressure (IOP) changes secondary to reduction of orbito-zygomatic complex fractures (with or without fixation) and recorded the Loss of vision or decrease in visual acuity which was rare but devastating complication of surgery involving the orbital skeleton.

The aim of this study was to investigate the intraocular pressure (IOP change of the eye preoperatively and postoperatively) of the involved eye following reduction and treatment of Orbital floor fractures or reconstruction of orbital floor following resection.

Thirty four patients who presented to the Oral and Maxillofacial Surgery Unit at El-Haram Hospital with displaced, Orbital floor fractures alone or in conjunction with other facial skeletal fractures requiring reduction and treatment or seeking reconstruction of orbital floor secondary to maxillectomy to prevent esthetic and functional deficits were enrolled in the study.

Of the 34 (31 male and 3 female patients) 26 patients requiring treatment of Orbital floor fractures alone (6 patients)or in conjunction with other facial skeletal fractures (20 patients) and 8 male patients seeking reconstruction of orbital floor following resection as a part of maxillectomy.

Of 68 eyes included in this study 46 eyes were reconstructed secondary to fracture of orbital floor 8 orbital floor were subjected to orbital reconstruction due to tumor surgery 14 eyes were control (no surgical interferences).

Time from injury until presentation averaged 3 days (range, 0 to 28 days), the interval from presentation to operation averaged 8 days (range, 0 to 12 days). At the time of initial presentation 21patients had inferior orbital nerve paraesthesia, 25 had sub conjunctival hemorrhage, 9 had diplopia, 3 had exophthalmos and 6 had enophthalmos.

This study approved that there were no significant differences in Intraocular Pressure (IOP) Changes Secondary to Orbital Floor Reconstruction after Tumor Resection or Orbital Floor Fractures.

INTRODUCTION

The pressure inside the eye is called Eye pressure or intraocular pressure. It is measured in millimeters of mercury (mm Hg). Normal eye pressure ranges from 10-21mm Hg. The term ocular hypertension usually refers to any situation in which the pressure inside the eye is greater than 21mm Hg It is measured using an instrument called a tonometer **[1,2]**.

Tonometry is a method used to measure the pressure inside the eye. Measurements are taken for both eyes on at least 2-3 occasions. Because intraocular pressure (IOP) varies from hour to hour in any individual, measurements may be taken at different times of day (e.g., morning and night). A difference in pressure between the 2 eyes of 3mm Hg or more may suggest glaucoma **[3]**.

Ocular hypertension should not be considered a disease by itself. Instead, ocular hypertension is a term that is used to describe individuals who is glaucoma suspect. High pressure inside the eye is caused by an imbalance in the production and drainage of fluid in the eye. The channels that normally drain the fluid from inside the eye do not function properly. More fluid is continually being produced but cannot be drained because of the improperly functioning drainage channels. This results in an increased amount of fluid inside the eye, thus raising the pressure **[3]**.

Reduction of midface fractures has been associated with the rare but devastating complication of blindness. An increase in intraocular pressure (IOP) is important in the mechanism of blindness. Several studies **[1,4,5]** assessed the intraocular pressure (IOP) changes secondary to reduction of orbito-zygomatic complex fractures (with or with-

out fixation) and recorded the Loss of vision or decrease in visual acuity which was rare but devastating complication of surgery involving the orbital skeleton. Same in addition to previous studies [6,7]. An increase in the compartment pressure of the orbit has been described by several authors as being responsible for change in visual acuity following repair of orbital floor after orbital fracture or orthogenetic surgery. The underlying assumption of these reports is that the orbit, because of its rigid bony skeleton and firm anterior soft tissue border, provides an environment conductive to a compartment pressure syndrome caused by retro bulbar hemorrhage or traumatic edema. Visual loss is thought to result from this in creased orbital pressure compromising the vascular supply of the optic nerve, choroids, and retina [8]. It is postulated [9] that the increased orbital compartment pressures can secondarily raise the intraocular pressure (IOP), which in turn can compromise the ocular blood supply some studies [10] have shown a decrease in retinal perfusion in patients with glau coma once the IOP reaches 80mmHg.

The goal in orbital treatment [11,12,13] is to prevent limitation of ocular motion by muscle entrapment, limit enophthalmos and preserve the volume of orbital bony bed. Shumrick [14,15]. Found in patients with concomitant zygomatic or midface fractures that the indications for orbital floor exploration are as follows: Persistent diplopia with a positive forced duction test, obvious enophthalmos, comminuted orbital rim by CT, greater than 50% floor disruption by CT, combined floor/medial wall defects by CT, fracture of body of zygoma by CT, and "blow-in" fracture with enophthalmos by physical examination or by CT [6]. As with zygoma fractures, Mathog [16]. Recommends a delayed period (7-10 days) as the optimal time to intervene in order to decrease swelling yet prevent long-term changes [8]. Knowing the anatomy of the orbit [17], its lack of flexibility and how small hematomas can create a "compartment syndrome" with an increase in intraorbital pressure, exophthalmos, vascular compression and/or compression of the optic nerve, with dramatic consequences [17,18]. So, gross malpostioning [19] of the globe should proceed with caution, particularly with posterior dissection or forceful globe handling. Also, presence of certain injuries such as hyphema, globe injury, and retinal tear surgical intervention should be delayed till medical stability [15,20].

Forrest et al. [21,22] showed a statistically significant rise in IOP following the placement of bone grafts to repair orbital floor fracture. The IOP change returned to baseline within 30 minutes and there were no reported change in visual acuity. They reported that [21,22]. Visual loss is an uncommon but catastrophic complication after intraorbital bone grafting for the reconstruction of acute traumatic defects or long-standing enophthalmos. Increased intraocular or intraorbital compartment pressure may be pathogenic in this setting.

The aim of this study:

The aim of this study was to investigate the intraocular pressure (IOP change of the eye preoperatively and postoperatively) of the involved eye following reduction and treatment of Orbital floor fractures or reconstruction of orbital floor following resection.

MATERIAL AND METHODS

Thirty four patients who presented to the Oral and Maxillofacial Surgery Unit at El-Haram Hospital with displaced, Orbital floor fractures alone or in conjunction with other facial skeletal fractures requiring reduction and treatment or seeking reconstruction of orbital floor secondary to maxillectomy to prevent esthetic and functional deficits were enrolled in the study. Patients were excluded from the study if they had previous orbital surgery on either the affected side or unaffected side, or if they had sustained a globe injury.

Preoperative details:

Every patient was prepared as per our routine practice; axial, coronal and three dimensional computed tomography scans (Fig. 2), examination of visual acuity, pupillary reflexes, extraocular eye movements, assessment of enophthalmos or exophthalmos.

Before surgery patient's medical status as well as signs and symptoms of the injury (visual acuity, degree of enophthalmos, pupillary and extra ocular muscle function, and the amount of diplopia) were recorded. The patient's document were carefully completed and reviewed.

The surgical procedure and the risks, benefits, and alternatives was explained clearly and documented. The patient was aware of the possibility of postoperative surgical the risk such as persistent, worsening, or new-onset diplopia, hypesthesia, and enophthalmos and visual affection. Written consent was obtained from all participants.

A meticulous review of imaging with a neuroradiologist was essential for planning the surgical approach and identifying surrounding structures that may serve as anchoring sites for an implant.

The appropriate implant was secure several days prior to surgery.

Intraocular pressure (IOP) were measured in mmHg using tonometry (McLean tonomter), in the involved eye and non-involved eye. Intraocular pressure (IOP) measurements were performed thee times preoperatively [twenty four hours preoperatively, twelve hours preoperatively and immediately after general anesthetic induction] and three times postoperatively [Post operation Immediately after fracture reduction. While still under general anesthetic (Fig. 1), seventy two hours postoperatively, and one week postoperatively]. These measurements were performed by the same individual on the same machine at approximately the same time of the day at every visit. (Pupillary response, visual acuity measurements) were carried out postoperatively on all patients as per usual practice.

Surgery usually was performed as close to 2 weeks from the trauma date as possible. This allows the swelling to subside and a more accurate examination of the orbit to be performed. Additionally, the scarring usually has not advanced enough to prohibit adequate surgical correction. In cases of orbital floor reconstruction Surgery was performed at least one month after tumor surgery.

Access to the orbital floor was made through the cutaneous approach commences with a skin-muscle flap elevation via an incision 2-3mm below the lower lid margin. This dissection was carried out anterior to the orbital septum until the orbital rim was exposed after Incision and liberation the periosteum from its bony attachments.

The fat were removed and an implant (titanium mash) was placed over the defect site fixed with titanium screws (Figs. 2,3). Following floor restoration, assess the fit and stability of the implant. special care was given to be sure the implant was not protruding, which can result in an aesthetically poor result, patient discomfort, and soft tissue breakdown, which can invite infection. The periosteum was sutured with a 4-0. At the end of the procedure the approach was covered with sterilize apposite.

Postoperative details:

The patient was instructed to use cool compresses (Gauze soaked in iced saline was gently placed over the closed eyelids) for 48 hours, to finish all prescribed oral antibiotics, and to use analgesics sparingly. A postoperative oral steroid was used to help reduce swelling.

RESULTS and Statistical Analysis

After facial trauma most patients presented with decreased visual acuity, blepharoptosis, binocular vertical or oblique diplopia, and ipsilateral hypesthesia, dysesthesia, or hyperalgesia in the distribution of the infraorbital nerve. In addition, patients complained of epistaxis and eyelid swelling following nose blowing. Periorbital ecchymosis and edema accompanied by pain were obvious external signs and symptoms, respectively. Enophthalmos may be discerned, but initially it can be obscured by surrounding tissue swelling. This swelling was restricted to extra ocular muscle motility, giving the impression of entrapment within the floor defect. Proposes may result from retro bulbar or per bulbar hemorrhage. Palpation of the orbit may reveal a bony step-off of the orbital rim and point tenderness.

Of the 34 (31 male and 3 female patients) 26 patients requiring treatment of Orbital floor fractures alone (6 patients) or in conjunction with other facial skeletal fractures (20 patients) and 8 male patients seeking reconstruction of orbital floor following resection as a part of maxillectomy.

Time from injury until presentation averaged 3 days (range, 0 to 28 days), the interval from presentation to operation averaged 8 days (range, 0 to 12 days). At the time of initial presentation 21patients had inferior orbital nerve parasthesia, 25 had sub conjunctival hemorrhage, 9 had diplopia, 3 had exophthalmos and 6 had enophthalmos.

Of 68 eyes included in this study 46 eyes were reconstructed secondary to fracture of orbital floor 8 orbital floor were subjected to orbital reconstruction due to tumor surgery 14 eyes were control (no surgical interferences).

Preoperative and postoperative intraocular pressure (IOP) measurements readings were tabulated. Paired *t*-tests were used to test the hypothesis that there was a difference in the IOPs preoperatively and postoperatively each patient (Table 1). There were no significant differences between preoperative and postoperative data. The data differences between preoperative and postopertave over time indicated a quadratic relationship. Average IOP was greater in the injured eye than in the control. The functional and aesthetic results was very satisfactory (Figs. 3,4).

There is evidence of a slight increased of IOP in both eyes of the same patients both means and medians appeared to increase by similar amounts.

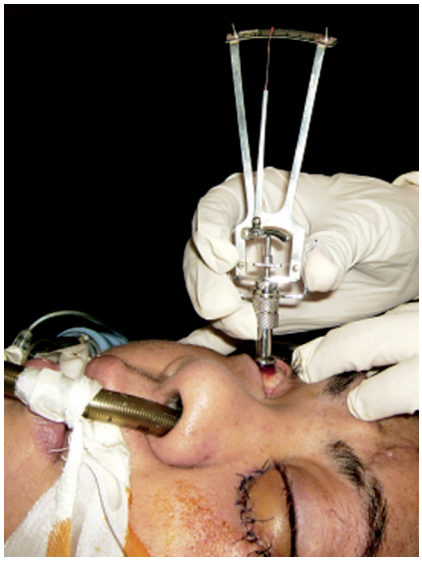
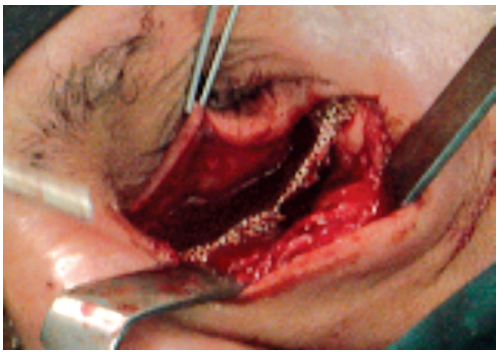
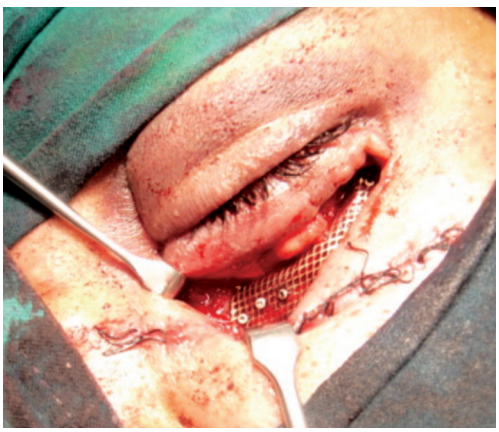


Fig. (1): The IOP was measured with a McLean tonomter Intraoperative.



(A)



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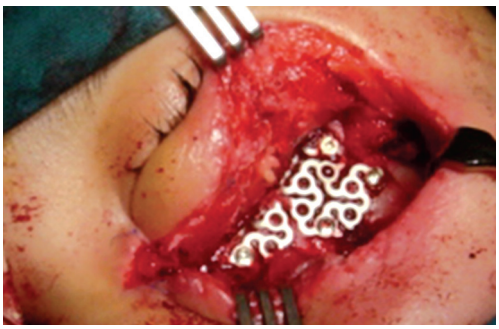

(C)

Fig. (2A,B,C): Titanium mash was placed over the defect site fixed with titanium screws.

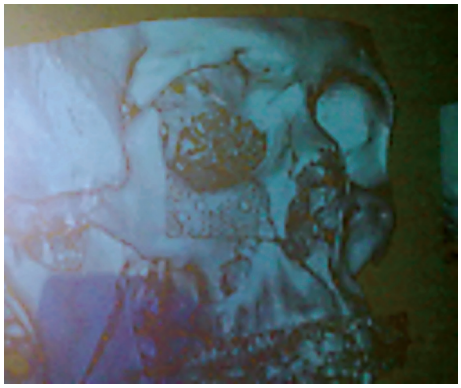

Fig. (2D): Three dimensional computer tomography showing placement of Titanium mash over the defect site fixed with titanium screws.

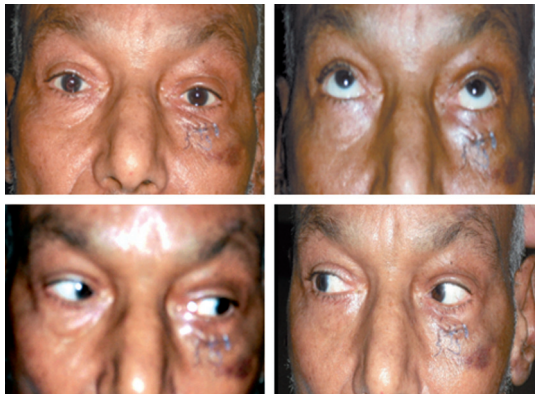

Fig. (3): A view of the patient with all directions orbital movements due to very satisfactory orbital floor reconstruction secondary to fracture of orbital floor.

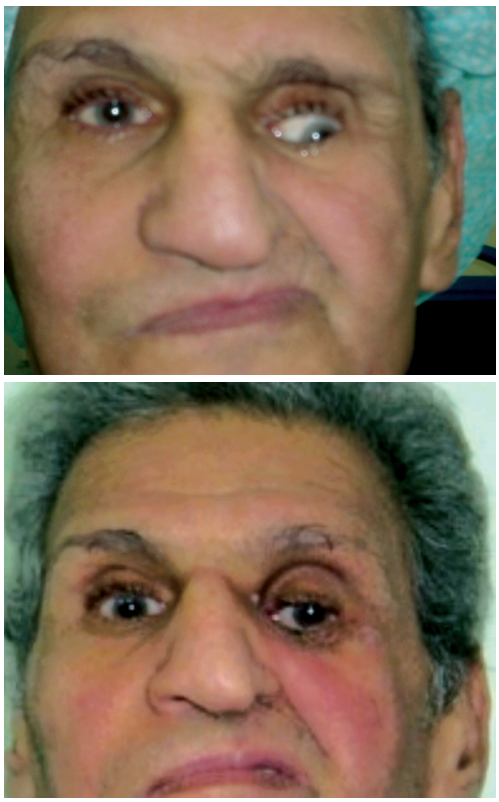

Fig. (4): A preoperative and post-operative orbital floor reconstruction due to tumor surgery.

Table (1): Matched pair tests for IOP differences preoperatively and postoperatively.

Eye	No. of eyes	Pre-op. Mean IOP (mmHg)	Post-op. Mean IOP (mmHg)	Pre-Post	Pairwise *t*-test (*p*-value)
F	46	21.4	16.9	5.05	0.06
T	08	21.2	16.7	4.50	0.16
C	14	18,8	18.2	0.6	0..833

F: Reconstructed secondary to fracture of orbital floor.
T: Orbital reconstruction due to tumor surgery.
C: Control (no surgical interferences).

Table (2): Matched sign-rank test for IOP differences preoperatively and postopertavly.

Eyes	No. of eyes	Pre Op. Median	Post Op. Median	Sign-rank test (*p*-value)
F	46	18	16.5	0.970
T	08	14.5	13.5	0.694
C	14	17	18,5	0.599

F: Reconstructed secondary to fracture of orbital floor.
T: Orbital reconstruction due to tumor surgery.
C: Control (no surgical interferences).

Table (3): Comparing pre and immediate post operative pressures.

IOP range mm Hg	Prep operative	Post operative
0-5	0	0
6-10	4	2
11-15	5	8
16-20	3	22
21-15	4	26
26-30	32	10
>30	20	0
Total	68	68

DISCUSSION

The main aim of surgical treatment of orbital fractures is to regain the shape and volume of the orbit and the way is to reduce fractures followed by fixation this in addition to relieve any trapped muscle or any herniated orbital tissues into maxillary sinuses which may create new situation around the eye causing change intraocular pressure. Any change in intraocular pressure (IOP) may cause serious problem. For example any increase in intraocular pressure (IOP) is important in the mechanism of blindness so reduction of midface fractures has been associated with the rare but devastating complication of blindness. Basically the ideal outcome is to try and re-establish the delicate anatomy of the orbit in order to restore its function and aesthetics.

Not only this study had evaluated the changes in intraocular pressure (IOP) and refraction following orbital compression or decompression secondary to orbital floor reconstruction after tumor resection or orbital floor fractures alone or in conjunction with other facial skeletal fractures but also has investigated the intraocular pressure (IOP) change in these subgroups individually. Most of patients in this study had a preoperative intraocular pressure (IOP) of more than 21mmHg (Table 3) which give high risk factors for glaucoma **[1]**.

This study demonstrate minor significant change of Intraocular pressure (IOP) is towards normal value; (Table 1) following orbital decompression but this change was greatly significant improved after one week post operatively when postoperative edema was completely subsided this occurs in fracture cases while in cases underwent orbital floor reconstruction after tumor resection it demonstrate significant change of Intraocular pressure (IOP) is towards normal value; immediately postoperative after reconstruction orbital floor. This two difference resulr may due to hemorrhage which is almost constantly accompanies orbital trauma and forms hematoma and ecchymosis. So, dense periorbita (periosteum) surrounding the eye should be observed for any change especially Hemorrhage which occur in three locations: The intraconal space, the extraconal space, and the subperiosteal space. Wolter JR **[23]** maintioned that such Hemorrhage especially Retrobulbar hemorrhage can be a devastating leading to blindness quickly after the trauma if not managed **[23]**. Huismans **[24]** showed that edema and infiltration of lymphocytes of and plasmacytes of ciliary-body, pathologic-anatomical substratum of the most changes of orbita in this disease, responsible for myopia and Ocular hypertension. Although orbital fracture (especially floor or medial wall fracture) might be assumed to allow. Automatic decompression of orbital hemorrhage into the adjacent sinus, in fact, clotting of the blood within the sinus can effectively prevent drainage of recurrent bleeding and therefore lead to renewed visual danger including Intraocular pressure (IOP) **[3,25,26]**. Treatment requires prompt evacuation and decompression of the space in which the hemorrhage has occurred. Medical treatments, such as large doses of intravenous corticosteroids or osmotics (such as mannitol), can aid in the management of hemorrhage, but immediate surgical decompression of the orbit remains the mainstay of treatment. Like, most other hemorrhages and formed hematomas will resolve on their own over time **[26,27]**.

Reduction in intraocular pressure (IOP) following orbital decompression were also decomented several literatures describing sush changes **[28-32]**.

Danesh-Meyer et al. [28] have reported a 6.9% drop in intraocular pressure (IOP) following bone removal orbital decompression in 116 eyes with a preoperative intraocular pressure (IOP) of less than 21mmHg and an even greater reduction in patients with elevated pre operative IOP. Dev et al. [33] have reported a mean reduction intraocular pressure (IOP) of 3mmHg in 22 eyes. The above two were retrospective studies. Kalmann et al. [29] who demonstrated a reduction in intraocular pressure (IOP) following orbital decompression and inferior rectus recession. Most of previous dtudis [24,26,30,32] demonstrated that edema, infiltration of lymphocytes, hemorrhages and formed hematomas are causes for the most changes of periorbita (periosteum) surrounding the eye and responsible for Ocular hypertension.

A prospective study including orbital volume calculations using 3D imaging conducted by Robert et al. [32] studies proved that D imaging would provide more accurate information on the indications for orbital decompression procedures.

Although the present study did find change in intraocular pressure (IOP) and refraction following orbital decompression but this change was not highly significant and was under our expectations at the beginning of the study. A previous study by Forrest et al. [34] reported a statistically significant rise in intraocular pressure (IOP) immediately after bone grafting orbital floor defects in 19 patients, All 19 patients had orbito-zygomatic complex fractures that required elevation and 3 point miniplates fixation before orbital floor reconstruction with split calvarial bone. The difference between this previous study that show significant rise in intraocular pressure and the present study that show significant change of Intraocular pressure towards normal value. May due to the use of two different materials used for reconstruction. In their study they used bone graft as grafted material while in this study titanium implant was used as implanted material which is more thinner to occupy large space in orbital of chamber and has less effects to change its volume producing minimal changein on intraocular pressure (IOP).

Titanium mesh and screws in internal fixation used was thin (1.0 and 1.3m.m.), easily manipulated to fixate complex shapes of the orbital floor and once the material is placed it does not need to be removed. It results in good healing and osseointegration. Although its main disadvantage of the material is that, when placed on the orbital floor it can be traumatically driven back into the orbital apex causing injury to the optic nerve. It had been adviced by Ian Holland [35] that because it is very rare it should not be a primary reason to not operate for titanium plates in orbital reconstruction. because this material is very suitable especially for larger fractures, medial wall reconstruction and when extensive reconstruction of the orbite is required. The disadvantage was overcome by bending the outer border of the mash to fit the anterior surface of infra orbital rim (Fig. 2).

Forrest et al. [22] also conducted a laboratory study where intraocular and intraorbital compartment pressures were measured during sequential orbital volume reduction in 3 groups of New Zealand white rabbits with intact orbits, acute orbital wall defects, and chronic orbital wall defects. it is interesting to note that intraocular pressure (IOP) was significantly elevated in all 3 groups compared with non-operated control orbits; however, intraorbital pressure values did not change significantly from control levels throughout the grafting sequence. This result also raises questions regarding the relationship between orbital compartment pressures and iops.Similar study was also conducted by Kaufman PL et al. [36] who reported statistically significant lower preoperative intraocular pressure (IOP) readings in orbito-zygomatic complex fractures requiring orbital floor repairs compared with orbito-zygomatic complex fractures not requiring orbital floor repair. It was postulated that this was because larger defects of the orbital floor allow decompression of the periorbital tissues. Pressure changes within the orbital compartment, in the context of facial trauma, and its subsequent effect on the intraocular pressure (IOP) and retinal microcirculation have not been fully elucidated. A distinction must be made between intraocular pressure (IOP) and intraorbital pressure. IOP, or pressure within the globe, is normally within the range of 10 to 20mmHg [17]. Intraorbital pressure is a measure of periorbital tissue pressure within the orbital compartment not only the bony size of orbital of chamber. Reimann et al. [37] introduced an orbital manometer into the orbital compartment of healthy patients to determine pressure before and after a retrobulbar injection of 5mL of anesthetic. The data collected showed a resting orbital compartment pressure of 4.0-1.5mmHg, which increased to 11.6-2.6mmHg, 5 minutes after the injection of 5mL of anesthetic. An earlier study using a “split-catheter” technique also showed similar resting orbital compartment pressures, with a range of 3.0 to 6.0mmHg [38] which prove that intraocular pressure (IOP) is mot only due to pathophysiology process but also mechanical dynamic condition. The study used the fellow eye as a control to compare the changes in intraocular

pressure (IOP) at 1 week following orbital decompression, but could not find a significant difference in intraocular pressure changes (IOP) between the operated and the unoperated eyes. Which may give be strong indication that intraocular pressure (IOP) is pathophysiology process rather than mechanical dynamic condition because High pressure inside the eye is Caused by an imbalance in the production and drainage of fluid in the eye. Paton et al. **[1]** reported in literature describing this imbalance as the channels that normally drain the fluid from inside the eye do not function properly. More fluid is continually being produced but cannot be drained because of the improperly functioning drainage channels. This results in an increased amount of fluid inside the eye, thus raising its intraocular pressure (IOP) **[1]**.

Suresh Sagili et al. **[39]** concluded same results that there was no significant difference in IOP between the operated and the contrlateral unoperated eye at 1week (p=0.1) postoperatively. The mean IOP in the contra lateral unoperated eye was 15.3±3.3mmHg and there was no change at 1 week (15.9±2.9mmHg, p=0.1) postoperatively.

Conclusion:

This study approved that there were no significant differences in intraocular pressure (IOP) changes secondary to orbital floor reconstruction after tumor resection or orbital floor fractures which mean that intraocular pressure (IOP) is pathophysiology process rather than mechanical dynamic condition because high pressure inside the eye is caused by an imbalance in the production and drainage of fluid in the eye.

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