Intraocular Pressure Changes in Trumpet Players

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Abstract

Objective: This study examines the intraocular pressure (IOP) changes that occur during trumpet playing.
Methods: In a prospective, non-randomized clinical trial, 28 eyes of 28 trumpet players were evaluated. IOP was measured using the Mentor Tono-Pen XL applanation tonometer in subjects before, during, and after trumpet playing.
Results: The IOP values during play (mean=26.32mmHg±7.39) were significantly higher than the baseline IOP values (mean=15.96mmHg±4.96), $t(1,27)=-9.237$, $p<0.0001$. The IOP values during play were also significantly higher than the resting IOP values following play (mean=15.50mmHg±4.28), $t(1,27)=10.122$, $p<0.0001$. The baseline IOP values did not differ significantly from the resting IOP values, $t(1,27)=0.836$, $p=0.410$.
Conclusion: IOP increases significantly in musicians while playing the trumpet. Patients with glaucomatous optic nerve damage and visual field loss who play high resistance wind instruments could be at increased risk for further damage from this intermittent increase in IOP regardless of average IOP control as measured in office.

Introduction

Increased intraocular pressure (IOP) is generally accepted as a major risk factor for the development of primary open-angle glaucoma.[1,2] Recently, several studies have suggested that IOP fluctuation and peak IOP may be independent risk factors for glaucoma, regardless of mean IOP as measured in office.[3-9] Certain activities are known to cause intermittent IOP elevations which, when taken into account over long periods of time, may increase an individual's risk for the development or progression of glaucoma. These activities include lifting heavy loads, coughing, and playing wind instruments.[10]

This study targets the trumpet as a high resistance wind instrument which may cause IOP elevation during play.[11,12] Trumpet playing may not immediately be thought of as an activity with many physical hazards. However, trumpet players may suffer such physical ailments as neurologic and orthopedic overuse syndromes, orbicularis oris rupture, and cerebrovascular ischemic events.[13,14] If trumpet playing increases IOP significantly, the development or progression of glaucomatous damage may be added to a trumpet player's list of potential health concerns.

Materials and Methods

Subjects

In this study, 28 eyes of 28 trumpet players were evaluated. All subjects gave signed consent for participation after being informed of the risks and benefits of the study (Appendices A & B). Subjects filled out a questionnaire providing information about age, race, gender, playing experience, and personal and family ocular history (Appendix C).

Equipment

IOP was measured in each subject before, during, and after playing the trumpet using the Mentor Tono-Pen XL applanation tonometer. The Tono-Pen is a compact, handheld instrument making it ideal for use in this study. The Tono-Pen is tapped gently on the central cornea, and the instrument displays the average of 4-10 measurements. It also displays a statistical reliability value for that average of 5, 10, 20, or >20%. A reliability value of 5% means that the averaged values are variable over a 5% range around the average. When the statistical reliability of the Tono-Pen measurements is 5%, its IOP measurements have been shown to correspond well with Goldmann applanation tonometry in the 11 to 20mmHg interval and fairly well in the 4 to 10mmHg and 21 to 30mmHg intervals.[15,16] At values greater than 21mmHg and especially over 31mmHg, the Tono-Pen tends to underestimate IOP.[15]

All IOP measurements were performed by the same examiner. The Tono-Pen was calibrated before each day's measurements as described in its instruction manual. A clean tip cover was placed on the instrument for each subject. Each subject was seated, and one drop of proparacaine HCl, 0.5% was placed in each eye. Baseline IOP of the right eye only was measured with the subject fixating a target at eye level in primary gaze. The examiner held the subject's superior lid against the orbital bone to keep the subject from blinking during measurement. Following baseline IOP determination, the subject was asked to play a fortissimo (very loud) note near the top end of his or her range (high pitch). (The frequency of a sound wave is called pitch. In music, different pitches are represented by notes.) After 15 seconds, while the subject continued to hold this note, IOP was again measured in the right eye. When this measurement was complete, the subject discontinued play and rested for 30 seconds at which time a final IOP measurement was made in the right eye.

Data Analysis

Paired t-tests were performed to analyze differences between IOP values before, during, and after play. Independent samples t-tests were performed to analyze differences between IOP changes based on gender, age, and playing proficiency. All data analysis was performed utilizing *SPSS 10.0 for Windows* statistical software.

Results

Subjects ranged in age from 18 to 74 years (mean=30.64±15.39). Twenty-three males and five females participated. Twenty-seven subjects were Caucasian and one was Indian. Years of playing experience ranged from 1 to 65 (mean=16.43±13.63). Hours of time spent playing the trumpet each week ranged from 0 to 28 (mean=8.71±7.73), (Fig. 1). One subject had a history of recurrent iritis, and 3 subjects had a history of LASIK all greater than six months prior to participation in this study. (IOP measurements in patients following LASIK may be falsely low due to decreased corneal thickness.[17] Since our study was concerned with the amount of change and not the baseline IOP values, these subjects were still included.) One subject had a family history of glaucoma.

Baseline IOP ranged from 5 to 27mmHg (mean=15.96mmHg±4.96). (Four subjects had a baseline IOP greater than 21mmHg. Each of these individuals was informed that this value is outside of what is considered the normal range of IOP[2], and the examiner recommended that they receive a comprehensive eye examination.) IOP during play ranged from 18 to 43mmHg (mean=26.32mmHg±7.39). Resting IOP measurements ranged from 9 to 28mmHg (mean=15.50mmHg±4.28), (Fig. 1-3).

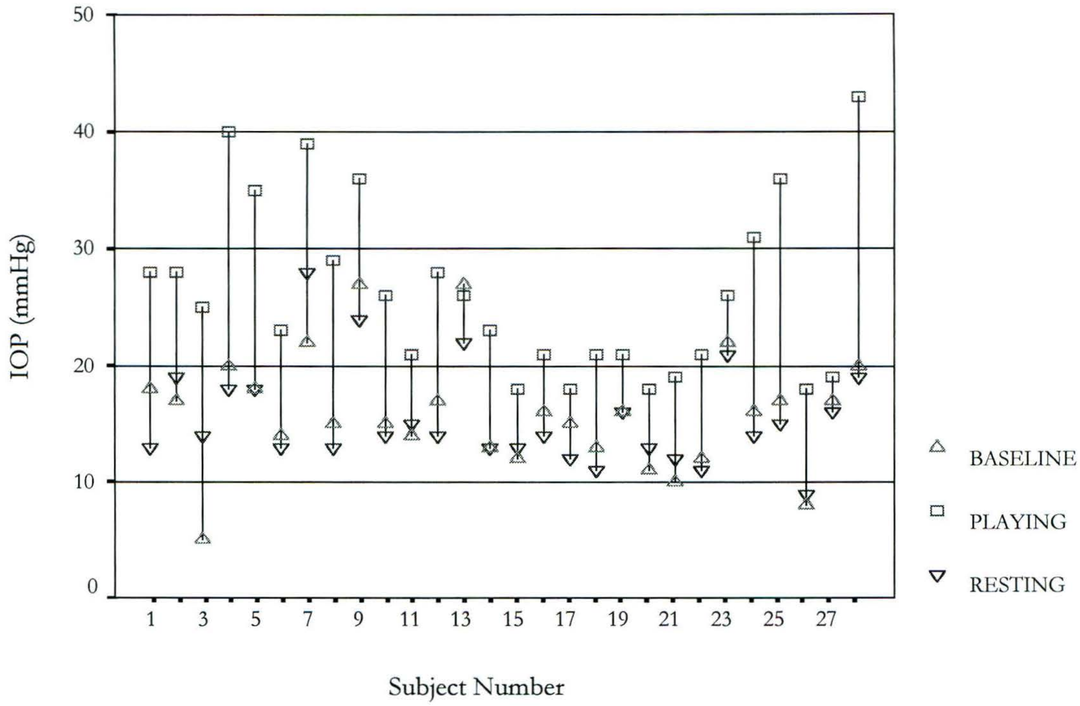
Figure 1: Subject Data

Subject No.	*Years of Age (Gender)*	*Years of Playing Experience*	*Average Hours Played per Week*	*Baseline IOP (mmHg)*	*IOP While Playing (mmHg)*	*Resting IOP (mmHg)*	*Change from Baseline to Playing (mmHg)*	*Change from Playing to Resting (mmHg)*
1	43(M)	33	15	18_{5}[b]	28_{5}	13_{5}	10	-15
2	24(F)	13	5	17_{5}	28_{5}	19_{5}	11	-9
3	19(M)	10	4	5_{5}	25_{5}	14_{5}	20	-11
4	19(M)	10	10	20_{5}	40_{5}	18_{5}	20	-22
5	21(M)	12	15	18_{5}	35_{5}	18_{5}	17	-17
6	20(M)	10	3	14_{5}	23_{5}	13_{5}	9	-10
7	18(M)	10	15	22_{10}	39_{5}	28_{5}	17	-11
8	22(F)	12	28	15_{5}	29_{5}	13_{5}	14	-16
9	21(M)	12	12	27_{5}	36_{5}	24_{5}	9	-12
10	48(M)	40	6	15_{10}	26_{5}	14_{5}	11	-12
11	21(M)	11	15	14_{5}	21_{10}	15_{5}	7	-6
12	19(M)	8	15	17_{10}	28_{5}	14_{5}	11	-14
13	19(M)	10	7	27_{5}	26_{10}	22_{5}	-1	-4
14	20(M)	10	24	13_{5}	23_{5}	13_{10}	10	-10
15	25(M)	15	0[a]	12_{20}	18_{5}	13_{10}	6	-5
16	24(F)	1	0[a]	16_{10}	21_{5}	14_{5}	5	-7
17	58(M)	14	0[a]	15_{10}	18_{10}	12_{5}	3	-6
18	21(M)	11	2	13_{5}	21_{5}	11_{5}	8	-10
19	25(M)	4	0[a]	16_{5}	21_{5}	16_{5}	5	-5
20	22(F)	6	0[a]	11_{5}	18_{5}	13_{5}	7	-5
21	23(M)	8	0[a]	10_{5}	19_{5}	12_{5}	9	-7
22	42(F)	33	3	12_{5}	21_{20}	11_{5}	9	-10
23	44(M)	34	20	22_{5}	26_{20}	21_{5}	4	-5
24	74(M)	65	15	16_{5}	31_{5}	14_{5}	15	-17
25	31(M)	22	7	17_{10}	36_{5}	15_{5}	19	-21
26	63(M)	6	5	8_{10}	18_{5}	9_{10}	10	-9
27	47(M)	25	8	17_{5}	19_{20}	16_{5}	2	-3
28	25(M)	15	10	20_{10}	43_{5}	19_{5}	23	-24

[a]Subjects reported less than one hour playing time per month.
[b]Subscripts following IOP values represent the statistical reliability value of averaged Tono-Pen measurements. Highlighted rows represent those subjects for which statistical reliability of 5% was achieved on all measurements.

One outlier's IOP decreased 1mmHg while playing. Each of the other subject's IOP increased with the minimum increase being 2mmHg and the maximum being 23mmHg (mean=10.36mmHg±5.93). Following a short resting period after playing, each subject's IOP decreased from a minimum decrease of 3mmHg to a maximum decrease of 24mmHg (mean=-10.82mmHg±5.66), (Fig. 1 & 2).

Figure 2: IOP before, during, and after play



The IOP values during play (mean=26.32mmHg±7.39) were significantly higher than the baseline IOP values (mean=15.96mmHg±4.96), t(1,27)=-9.237, p<0.0001. The IOP values during play were also significantly higher than the resting IOP values following play (mean=15.50mmHg,±4.28), t(1,27)=10.122, p<0.0001. The baseline IOP values did not differ significantly from the resting IOP values, t(1,27)=0.836, p=0.410. (Fig. 3)

Figure 3: Data Analysis **IOP (mmHg)**

	Mean	Range	Std. Deviation	
Baseline	15.96	5-27	4.96	
Playing	26.32	18-43	7.39	
Resting	15.50	9-28	4.28	
Change from Baseline to Playing	10.36	-1-23	5.93	p<0.0001
Change from Playing to Resting	[10.82]	[3-24]	5.66	p<0.0001

There was no significant difference in IOP changes based on gender, age, or playing proficiency (Fig. 4). Race could not be analyzed as a factor influencing IOP change since only one non-Caucasian subject was evaluated.

Figure 4: IOP changes based on gender, age, and playing experience

	N	Mean Change (mmHg)	Std. Deviation	
Change from Baseline to Playing				
(Male)	23	10.61	6.37	
(Female)	5	9.20	3.49	t(1,26)=0.474, p=0.639
Change from Playing to Resting				
(Male)	23	-11.13	5.96	
(Female)	5	-9.40	4.12	t(1,26)=-0.613, p=0.545
Change from Baseline to Playing				
(age>=50)	3	9.33	6.03	
(age<50)	25	10.48	6.04	t(1,26)=-0.311, p=0.758
Change from Playing to Resting				
(age>=50)	3	-10.67	5.69	
(age<50)	25	-10.84	5.77	t(1,26)=0.049, p=0.961
Change from Baseline to Playing				
(hours>=15)	9	11.67	4.47	
(hours<15)	19	9.74	6.53	t(1,26)=0.798, p=0.432
Change from Playing to Resting				
(hours>=15)	9	-12.33	4.58	
(hours<15)	19	-10.11	6.08	t(1,26)=-9.72, p=0.340

Discussion

Playing the trumpet requires appreciable skill to control lung volume, diaphragmatic mechanical force, and oropharyngeal and intrathoracic pressure in order to create sounds accurately over a wide range of frequency and volume.[18] At high frequency and loud volume, trumpet playing requires a Valsalva-type maneuver (forced expiration against a closed glottis[19]) to create sufficient oral airway pressure.[10] This Valsalva-type maneuver causes increased episcleral venous pressure which in turn causes an increase in IOP[11,12,20,24], as was observed in our study.

To adequately understand the physiology involved, a brief review of the dynamics of aqueous humor outflow is in order. Conventional outflow accounts for most of the fluid movement out of the eye by way of the trabecular meshwork. Aqueous passes through the trabecular meshwork to Schlemm's canal from where it exits via collector channels and moves into the episcleral veins. Uveoscleral outflow accounts for a lesser amount of fluid drainage. Aqueous humor passes through the anterior ciliary body and the iris to reach the supraciliary and suprachoroidal spaces and eventually the vortex veins.[1,2]

Conventional outflow is highly dependent upon the hydrostatic pressure gradient that exists between IOP and episcleral venous pressure (EVP).[1] IOP must stay above EVP in order for aqueous to drain via this pathway. Uveoscleral outflow is much less dependent on a pressure gradient. For example, with normal aqueous production, an IOP of 20mmHg, and an EVP of 10mmHg (average EVP ranges from 8 to 11.5mmHg[1]), most fluid will drain via the conventional pathway, and the percentage of uveoscleral outflow will be low. At an IOP closer to EVP, conventional outflow nearly ceases, and uveoscleral outflow accounts for a larger percentage of fluid drainage out of the eye.[2]

Increased EVP is known to lead to increased IOP.[1,20-23] Chronic, pathological conditions that directly raise EVP (e.g., orbital and intracranial arteriovenous fistulas) are known to cause increased IOP and glaucoma. Likewise, secondary IOP elevation is seen when venous drainage of the eye is obstructed either locally (e.g., retrobulbar tumor) or more remotely (e.g., superior vena cava obstruction).[1,20,21] Experimental methods inhibiting venous drainage have shown a 0.8mmHg increase in IOP for every 1mmHg increase in EVP.[22] A study on the effect of inverted body position on IOP demonstrated a 1mmHg increase in IOP for every 1mmHg increase in EVP.[23]

EVP may also be elevated during a Valsalva maneuver. During a Valsalva maneuver, intrathoric pressure increases causing compression of the intrathoracic venous system. This creates a rise in pressure of all the veins of the body including the episcleral veins as well as the vortex veins.[10,20] Studies measuring IOP in individuals while performing a Valsalva maneuver have demonstrated IOP elevations of up to 18mmHg.[20,24]

This mechanism occurs during straining activities such as coughing, vomiting, defacating, and lifting.[10] It also occurs while playing high-resistance wind instruments such as the trumpet, French horn, oboe, and bassoon.[10,11,25] Korner et al.[26] found an increase in peripheral venous pressure of 7mmHg for every 10mmHg increase in airway pressure during Valsalva maneuvers. Professional trumpet players often produce an oral airway pressure of 80mmHg or more and hold it for several seconds. It is clear then, how trumpet playing could cause pronounced IOP elevation.

Our study showed a significant increase in IOP during trumpet playing. Although future study may employ the use of a venomanomater to measure episcleral venous pressure directly during trumpet playing, we can conclude from the results of previous studies[11,12,24,27] and from our knowledge of aqueous humor dynamics[1,2], that increased episcleral venous pressure could account for the IOP changes seen here. Schuman et al.[11] performed ultrasound biomicroscopy on subjects while playing high resistance wind instruments. They found an increase in choroidal volume during play and proposed that this impedes uveoscleral outflow causing an increase in IOP. However, it is uncertain whether the increased choroidal volume actually causes the increase in IOP, or whether episcleral venous pressure rises rapidly, overwhelming the pressure gradient between the anterior chamber and episcleral veins leading to an increase in outflow by the uveoscleral pathway. This increased uveoscleral outflow could then account for the increased choroidal volume observed by Schuman et al. The exact mechanism of increased IOP during trumpet playing remains unclear, but it likely combines several factors.

In our study, IOP decreased immediately (within 30 seconds) following play, and there was no significant difference between IOP before and after play. Aydin et al.[12] measured IOP in wind instrument players before and after a 90-minute symphony orchestra performance and found a statistically significant increase following the performance. Although the change in IOP was small (mean change of +1.42mmHg), the mean percentage change (+9.6%) was found to be significant. The mean IOP of our subjects following play was actually 0.46mmHg lower than baseline. There may be some longer-lasting effect on IOP after playing for 90-minutes rather than only 15 seconds which could explain this difference.

Our study revealed no significant difference in IOP increases in more experienced versus less experienced trumpet players. This is interesting as previous studies involving wind instrument players have suggested a difference between the two groups that might translate to a difference in the magnitude of the Valsalva-type maneuver that occurs during high frequency, fortissimo play.[18,28] In a study of respiratory control in wind instrument players, it was suggested that more experienced players appear to have some additional inherited or acquired skills, such as enhanced respiratory perception and ventilatory neuromuscular control, that might lead to better control of intrathoracic pressure in professional as compared with non-professional musicians.[18] In a similar study evaluating mouthpiece forces produced while playing the trumpet, Barbenel et al.[28] found a significant difference in forces required to produce notes with ascending pitch and loudness between medium and high proficiency players. Both groups required increased mouthpiece force at higher pitch and louder volume, demonstrating the nature of the difficulty in playing these notes.

Our study did not control the specific frequency or volume of the note that the subject played. Each subject was asked to a play a loud note near the top of his or her range. Thus, a different frequency and volume of note was produced by each subject. If the less experienced players were asked to play the higher notes that the more experienced players produced, we may have found a greater increase in IOP due to the increased force required to produce these notes. Likewise, if the more experienced players were asked to play the lower notes like those produced by the less experienced players, less effort may have been required and the change in IOP would likely have reflected this. This may also explain why our study showed such a wide range of changes in IOP (range= -1 to 23mmHg). Future study could control this variable by having each subject play specific scales of notes and monitoring pitch and volume electronically while continuously measuring IOP with a pneumatonometer.

The changes we measured were at high pitch and loud volume, which would only account for a percentage of playing time during a typical rehearsal or performance. The proposed future study mentioned above would provide a more realistic evaluation of the IOP changes that would occur in a musician during a typical rehearsal or performance. For example, if IOP increases in an individual from a baseline of 20mmHg to 40mmHg (a 100% increase) while playing a loud high note, it would be useful to determine the percentage change at various pitches and volumes. Schuman et al.[11] employed a pneumatonometer to provide continuous measurement of IOP during high-resistance wind instrument playing and observed a small, but measurable increase even at low pitch and volume with a greater IOP increase as pitch and volume rose. However, this was done over a period of only 30 seconds. If it could be tolerated by subjects, continuous monitoring of IOP over a longer period of time would provide useful, practical information.

Clinically, we must evaluate whether the intermittent increases in IOP in trumpet players are enough to increase their risk for either the development or progression of glaucoma. To our knowledge, the only study that has directly investigated the correlation between high resitance wind instrument playing and the development of glaucoma is one by Schuman et al.[12] This study evaluated visual field loss and optic nerve head appearance in nine high resistance wind instrument players, 12 low resistance players, and 24 non-wind players. They found a small but significantly greater incidence of glaucomatous damage in the group of high resistance players. Although future investigations should involve larger numbers of high resistance players, this suggests that the cumulative effects of intermittent increases in IOP may be sufficient to increase these individuals' risk over a long period of time.

Well established non-ocular risk factors for primary open-angle glaucoma (POAG) include age, race, family history of the disease, diabetes mellitus, and vascular disease.[2] Ocular risk factors include myopia, increased cup to disc ratio, asymmetric cupping, and elevated IOP. With the prevalence of normal tension-glaucoma (NTG, glaucomatous cupping and visual field defect in the absence of IOP greater than 21mmHg[2]) and the results of studies indicating that factors such as family history may be more accurate predictors for development of the disease[29,30], less emphasis is now being placed on IOP. Yet, it remains an important risk factor and the means by which we treat glaucoma.

Certain activities are known to increase IOP intermittently (posture, forcible lid closure, Valsalva maneuver[2,23,27]). When making diagnostic and therapeutic decisions, the clinician should be cognizant of those factors which may alter a patient's prognosis. Any supplementary information which puts an in office IOP reading in context for the practitioner will aid in his or her handling of the case.[31]

When evaluating a patient for POAG, clinical decision-making is fairly straightforward when the individual has an IOP greater than 21mmHg, an increased cup to disc ratio, and a glaucomatous visual field defect. It is when the IOP is not elevated that the clinician must begin the investigative process to explain glaucomatous changes. Before concluding that a patient has NTG, the clinician must consider alternatives. Figure 5 outlines the differential diagnoses for NTG.[2] Among other things, patients must be questioned regarding systemic β-blocker treatment, past steroid use, and serial tonometry must be performed to determine the presence of diurnal variations in IOP.

Figure 5: Differential diagnosis for NTG once the diagnosis of POAG has been established

Elevated intraocular pressure not detected	Glaucoma in remission
1. Undetected wide diurnal variation	1. Past corticosteroid administration
2. Low scleral rigidity	2. Pigmentary glaucoma
3. Systemic medication that may mask elevated IOP (β-blocker treatment)	3. Associated with past uveitis or trauma
	4. Glaucomatocyclitic crisis
4. Elevation of IOP in supine position only	5. Burned-out POAG

The presence and importance of diurnal IOP fluctuation in individuals has been studied extensively. In normal individuals, IOP varies an average of 3-6mmHg over the course of a day.[3,32-35] Patients with POAG have much wider ranges of IOP in their diurnal curve.[33,34,36] Although the peak is most often recorded in the morning, there is great individual variability, and the peak may occur at any time throughout the day.[3,31-37] A number of authors have purported the role of home tonometry to accurately detect IOP fluctuations and peaks.[8,9,32]

Research has suggested that diurnal fluctuation and IOP peaks themselves may be critical prognostic indicators of glaucoma progression. Katavisto[3] found that, despite therapy, deterioration was fasted in eyes with high diurnal IOP variations. Likewise, Stewart et al.[4] found that the mean standard deviation for IOP in individuals with progression of glaucomatous damage (5.1mmHg) was higher than in patients without progression (3.9mmHg). Alpar[5] reported that patients with ocular hypertension and home tonometry values 4 to 13mmHg above their in office readings exhibited progressive glaucomatous damage within two years. Zeimer et al.[6] found that patients with progressive visual field defects had a greater frequency of IOP peaks (peak defined as a measurement of 6mmHg above any office reading) as compared with patients with stable visual fields or non-glaucoma patients. Gonzalez et al.[7] evaluated patients with ocular hypertension and found that 64% of patients with IOP peaks greater than 5mmHg above in office readings developed visual field defects within four years, while 82% of patients without such peaks maintained normal visual fields for greater than 5 years. Asrani et al.[8] found that a large fluctuation in diurnal IOP is, in and of itself, a significant risk factor for progression of glaucoma, independent of parameters obtained in office.

Another study by Zeimer et al.[9] employed home tonometry to detect early morning IOP peaks that declined rapidly in less than half an hour after waking. Here, a peak was defined as an early morning measurement at least 3mmHg greater than the average home tonometry readings for the rest of the day. They concluded that the presence of these peaks is "alarming", especially if they occur on a daily basis and if the eye is glaucomatous, thus already possessing an increased susceptibility to damage from increases in IOP.

If one accepts that fluctuation in IOP and IOP peaks are independent risk factors for progression of glaucomatous damage, then the clinical implication of our study on trumpet players becomes clear. Peaks of 3mmHg above the daytime average IOP lasting for only 30 minutes have been considered "alarming".[9] Our trumpet players demonstrated peaks during play of up to 23mmHg higher than baseline and a percentage increase of up to 400%. One professional trumpet player demonstrated a 14mmHg increase during play and reported playing time of at least 4 hours each day. As mentioned previously, since a typical rehearsal or performance would not involve playing loud high notes the entire time, future study needs to evaluate IOP changes over a wide range of pitch and volume. Such increases in IOP in young, healthy patients are not likely enough to independently place them at risk for development of glaucoma. However, such IOP increases in previously diagnosed glaucoma patients with fragile optic nerves may place those individuals at increased risk for progressive damage.

The results of this study and ones like it should aid the clinician when managing a patient with apparently well-controlled IOP as measured in office who continues to show progression of glaucomatous damage. Patients should not only be questioned as to therapeutic compliance, but also regarding activities such as trumpet playing which may cause intermittent increases in IOP.

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Intraocular Pressure Changes in Trumpet Players

Jennifer M. Jacobs, Senior Intern
Michigan College of Optometry
Senior Thesis

ABSTRACT

This study examines the intraocular pressure (IOP) changes that occur during high resistance wind instrument playing. Specifically, this study will target the trumpet, an instrument which has been shown in previous studies to cause increases in IOP during play. It has been hypothesized that this increase in IOP is due to uveal thickening which occurs via a Valsalva maneuver associated with wind instrument playing.

In this study, IOP will be measured in 30 trumpet players before they begin playing to establish a baseline reading for each subject. Subjects will then be asked to play a note of high pitch and loud volume, and IOP will be measured after 15 seconds. When this measurement is complete, the subject will stop playing, and IOP will be measured after 30 seconds of rest. IOP values will be compared in order to qualitatively and quantitatively evaluate any change that occurs during and after play.

This study and ones like it may have major implications for both musicians and eyecare professionals. Intermittent elevations in IOP may have long-term effects resulting in glaucomatous damage, which could be misdiagnosed as normal-tension glaucoma. Musicians would need to be aware of this risk, and eyecare professionals may need to add to their list of risk factors for glaucoma.

RISK/BENEFIT DISCLOSURE

The use of the Tono-Pen applanation tonometer to measure intraocular pressure (IOP) does not, in and of itself, pose any risks to the subject. The procedure requires the examiner to touch the sterile tip of the instrument lightly against the subject's cornea, the front surface of the eye. An ophthalmic drop, proparacaine, HCl (0.5%) will be instilled prior to measurement in order to anesthetize corneal sensitivity. Minor adverse effects of this drug are rare and may lead to temporary dry eye or foreign body sensation following cessation of the drug's numbing effect[1]. Subjects will be supplied with over-the-counter lubricant eye drops to use as needed following the procedure.

Measurement of IOP is part of a comprehensive eye examination and is one indicator for the disease, glaucoma. This study is not meant to serve as a glaucoma screening, however, if abnormally high baseline IOP is detected in a subject, a comprehensive eye examination by a licensed optometrist will be recommended.

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SUBJECT CONSENT FOR PARTICIPATION IN STUDY

____
Print Name Here

You are being asked to participate in a study in which Jennifer M. Jacobs of the Michigan College of Optometry at Ferris State University will measure intraocular pressure (IOP) using the Tono-Pen applanation tonometer. You have read the study abstract describing the procedure involved which is a commonly accepted part of a comprehensive eye examination. You have also read the risk/benefit disclosure statement describing the rare adverse effects of the ophthalmic drop being used. You have been made aware of the benefits of the study, and realize that although this procedure constitutes part of a glaucoma screening, it is not intended to serve as such a screening.

Results of this study will be included in the examiner's Senior Thesis, a required component of the curriculum at the Michigan College of Optometry. Results may also be published in an optometric journal. Your privacy will be protected to the maximum extent allowable by law, and you will not be identified personally in any way.

Declining to participate will in no way affect your status in the ensemble. You may withdraw from this study at any time.

By signing below, you indicate your agreement to these terms, and you volunteer for this study free of duress and without demand for compensation.

____
Signature of Participant Date

____
Witness

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SUBJECT QUESTIONNAIRE and DATA SHEET

Age: Male Female
Race:
How many years have you been playing the trumpet?
How many hours per day/days per week do you usually play the trumpet? Hours per day: Days per week:
Is there a specific time of the day that you usually play the trumpet? Y N If yes, when?
Have you played the trumpet today? Y N When and for how long?
What size mouthpiece do you use?
When was your last eye exam?
Have you ever had any eye injuries or eye surgeries? Y N If yes, please explain:
Have you ever been told that you have glaucoma or are a glaucoma suspect? Y N If yes, please explain:
Have you ever been told that you have any other eye diseases? Y N If yes, please explain:
Does anyone in your family have glaucoma? Y N If yes, what relation?
Before participating in this study, had you ever been told that playing the trumpet may put you at risk for developing glaucoma? Y N If yes, by whom? (i.e., band director, eye doctor, etc.)

	BEFORE PLAYING	**AFTER 15 SECONDS OF PLAYING**	**AFTER 30 SECONDS OF REST**
IOP (mmHg)	SDII:	SDII:	SDII:

Date:	M H E	S HCL SCL	Subject #: