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### RESEARCH ARTICLE

#### EVALUATION OF TONGUE FORCE USING PIEZOELECTRIC SENSOR IN TONGUE THRUSTING PATIENTS

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#### Abstract

Tooth position and the form of the dental arch are subject to constant pressure from the circum-oral muscles and the tongue. Stable maintenance of the position of the teeth and the form of the dental arch is thought to depend on the balance of these pressures. Literature regarding the association of tongue force and the malocclusion remains controversial. Hence the present study aimed to measure the tongue force among the tongue thrusting patients using piezoelectric sensor and to compare with the control group. The results of the present study showed that there was no statistical significant difference between the two groups. This could be because of small sample size, which leads for future scope to increase in the sample size.

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#### Introduction:-

Dental arch and the teeth are positioned between balancing forces of tongue internally and circum-oral muscles externally. The role of tongue in Oro-facial development has interested the researchers to study the strength of the tongue and its coordination. Ballard in 1955 has shown that the tongue forces exceeds that of lips.. Barlow and colleagues used electronic strain gauges to quantitatively evaluate lip, jaw, and tongue muscle control in individuals with motor speech impairment<sup>1,2</sup>. Dworkin and associates<sup>3</sup> developed a minimally invasive method of measuring forward and side tongue thrust using a miniature load cell placed between the teeth<sup>3</sup>. Despite significant advances in technology and imaging, there remains an incomplete understanding about tongue force ,its magnitude and timing. Hence influence of tongue force on malocclusion remains debatable. According to Proffit and Fields, tongue position at rest may have a greater impact on tooth position than tongue pressure, as the tongue only briefly contacts the

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lingual surface of the anterior teeth during thrusting<sup>4</sup>. However Takahiro Ono (2004), study using experimental palatal plates with pressure sensors located in 7 different areas of palate, concluded that the tongue pressure was generated initially by close contact with the antero-medial part of the tongue. Also magnitude and duration were significantly larger in the antero-medial part compared to other six parts measured<sup>5</sup>. Literature about tongue portraits mixed results regarding the posture and force of the tongue. Therefore this study aims to measure, quantify the antero-medial tongue force among subjects with tongue thrusting habit and compare with the control group.

**Materials and Methods:-**

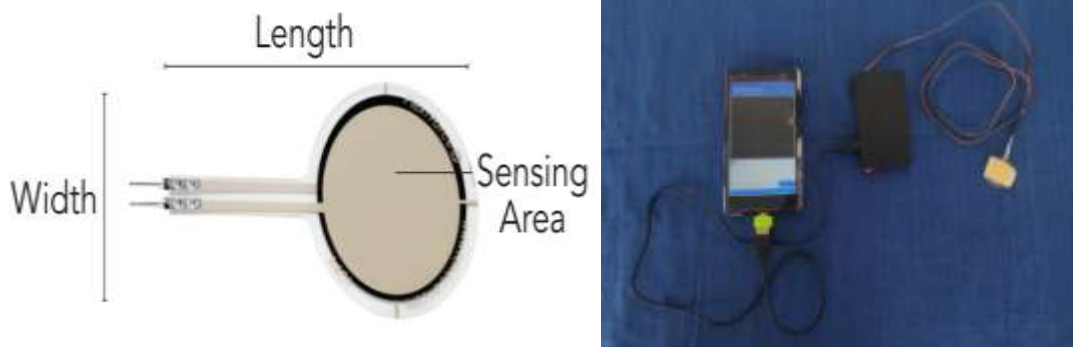
**Source of data:**

The current study is a cross sectional descriptive study, conducted among patients reporting to Department of Orthodontics and Dentofacial Orthopedics (Best Dental Science College and Hospital) from March 2021-August 2021. The study comprised of 2 groups, study group included subjects with tongue thrusting habit and a control group comprising of subjects with mature swallowing pattern. The selected age group (Table 1) was between 20-30years, with equal gender distribution was taken. The inclusion criteria for the study group were, subjects with clinical presentation of retained infantile swallowing pattern, also subjects with bidental protrusion, anterior openbite, Angles Class II div 1 malocclusion were considered. Exclusion criteria was patients with missing anterior tooth /teeth.

**Methodology:-**

The subjects were assessed for tongue thrusting habit under strict aseptic precautionary measures. Subjects were instructed to sit upright and asked to swallow saliva, during swallowing the tongue position was evaluated by depressing the subjects lower lip with operator's thumb. The subjects were diagnosed as a tongue thrusters if he/she fulfilled any one of the following criteria established by Weiss and Van Houten<sup>6</sup>.

A Thin, customizable flexiforce A401 sensor (fig 1) from TEKSCAN manufacturers, Boston, USA was employed to measure the tongue force during swallowing. This device uses electronic technology and comprises a sensing area and embedded circuits with bluetooth connectivity. Thickness of the sensor is 0.203mm(0.008"), length 56.9mm (2.24"), width 31.8mm(1.25")sensing area 25.4mm (1").This helps us to measure the tongue force in closed mouth position.



**Figure 1:-** Flexiforce A401 sensor.

The sensor was covered with a sealed sterilization pouch to protect the individuals against contamination. Before recording the force, the individuals were previously educated to perform their swallowing pattern over the device. The sensor was placed inferior to the incisive papilla and lingual to the maxillary incisors. Tongue pressure during dry swallow was recorded. With the help of certified calibrations the analog values were converted into standard values (kg).

**Results:-**

The data were collected and assessed using SPSS version 21 software. The mean tongue force among control group was 1.266 kgs with the standard deviation of ±0.10. While the mean force of the tongue in study group was 1.39 kgs with the standard deviation of ±0.16 (Table 2). There was no significant difference among the gender. Although clinically the tongue force was more among tongue thrusting individuals as compared to the control group, statistically it was not significant.

Groups	N	Mean	Std Deviation	Std Error mean	Sig.
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Control	10	24.9000	2.72641	0.86217	0.1
Study	10	22.9000	3.34830	1.05883	

**Table 1:-** Age wise distribution of the subjects.

	MEAN±SD	95% Confidence Interval(mean)		Sig.
		Lower	Upper	
Control	1.2660±0.10	1.2020	1.3280	0.58
Study	1.3940±0.16	1.2960	1.4820	

**Table 2:-** Comparison between the mean tongue force between two groups.

### Discussion:-

Tongue has a versatile role of mastication, swallowing, speech and articulation by contacting the palate<sup>7</sup>. Measuring the tongue pressure against the hard palate is a challenging procedure for the non-invasive method of quantitative evaluation of tongue activity<sup>7</sup>. However in this study non-invasive method was followed. Although the IOWA Oral Performance Instrument and the handy probe are useful in basic assessment of tongue pressure, these devices are not suitable for evaluating natural swallowing as they must be used without bringing the teeth into occlusion<sup>7</sup>. Similarly TOMS (tongue force measurement system) used by Robinovitch (1991) was also performed with open mouth method<sup>8</sup>. The major drawback of these methods was that certain muscle groups were inhibited with the open mouth position, which affected the tongue strength. This shortcoming is also been taken care in the present study, by using very thin sensor which can be stabilized with tongue while the patient closes mouth during swallowing. Also considering the inter-subject variability in the magnitude of tongue pressure the dry swallow was preferred over wet swallow.

Walter Straub in the 1950's observed that incorrect swallowing was a major cause of anterior open bite and incisor protrusion<sup>9</sup>. However Wallen (1974) in his study concluded that forward tongue position during swallowing, which usually is called tongue thrust is more likely to be an effect than cause<sup>10</sup>. He further explains relatively high position of the incisors keeps the tongue from contacting them so much during swallowing, denying the hypothesis tongue placement causes openbite. While few other study shows the tongue thrusting is associated with openbite, long facial pattern, proclination of upper anterior teeth. Other associated features with tongue thrust have been high and/or narrow maxillary arch and Class II div1 malocclusion.

As the literature gives varied conclusions regarding the tongue thrust and its effect on malocclusion, the present study was aimed to evaluate the magnitude of tongue among the subjects with tongue thrusting habit. Although the results of this study is statistically insignificant, clinically the tongue force seemed more than the counteracting force of perioral muscles. This mismatch could be due to small sample size. All the steps in the study were carefully designed and meticulously implemented. However inclusion of larger sample size could have given us a conclusive result, aiding to resolve the controversy of association of tongue thrusting force and malocclusion.

### Conclusion:-

This study was designed to evaluate and quantify the magnitude of tongue force among tongue thrusting patients. This spotlights the correlation of the tongue force, its effects on malocclusion and relapse rate. Although the results of the study was contradicting the clinical examination. This leaves for the future scope of this research to include more sample size.

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