

# Estimation of wettability of topical fluoride gel on anterior and posterior teeth: An *in vitro* study

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## ABSTRACT

The surface area determination has a vital role in measuring the properties of liquid and solid substances. Fluoride is a potent remineralizing agent of the teeth. The surface area is measured using a goniometer. The main aim of this study is to estimate the wettability of topical fluoride gel on the anterior and posterior teeth surfaces. Topical acidulated phosphate fluoride (APF) gel was taken in small quantities. Anterior and posterior teeth were collected, and their superficial unaltered enamel sections were used as the surface where the contact angle (CA) is determined. The surface wettability is determined using Ossila goniometer to measure CA. Each stage was mounted on a mechanical stage of the goniometer. A calibrated microsyringe was used to dispense drops of the APF gel over the surface of the specimen Group A (anterior tooth cut section) and Group B (posterior tooth cut section). This procedure is repeated for all specimen samples. The mean of CAs of the anterior teeth (88.41°) was greater when compared with the mean of posterior teeth (80.36°) CA. *P* value found using the paired *t*-test of SPSS software is found to be 0.271 (>0.05), hence statistically not significant. The greater the CA, the lower is the degree of wettability on the teeth surfaces. The mean CA of the topical fluoride APF gel on the anterior tooth surface is greater when compared to the posterior tooth surface. This signifies that greater wettability is seen on posterior tooth surfaces.

**Key words:** Contact angle, goniometer, hydrophilic, hydrophobic, innovative measurement, wettability

## INTRODUCTION

Wettability is the unique capability of the liquid to be in contact with the surface of the solids.<sup>[1]</sup> Wettability is a liquid's capability to make an intermolecular interaction

with the solid surface. It is the ability of the liquid to spread uniformly on the surface of the solid.<sup>[2]</sup> One of the distinct characteristics possessed by the liquid is that it acts on the solid surface, and it is the main reason for various properties such as adhesion, self-cleaning, and heterogeneous nucleation. Any liquid wets the surface of an object by mediating through the micropores present on the surface of the solid.<sup>[3]</sup> The degree of wettability of a liquid on the solid surface or the degree of the solid to get wet can be estimated easily with the help of the measurement of the contact angle (CA).<sup>[4]</sup> CA is the angle between the liquid surface and the outline of the solid

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surface. Surface roughness is important when compared to other factors that should be taken into account when assessing the CA. Hydrophobic and hydrophilic analysis of various heterogeneous molecules can be categorized using the analysis of the CA.<sup>[5]</sup> The tendency of hydrophobic molecules and hydrophilic molecules to form droplets and disperses can also be characterized by the CA analysis between the fluid and surface.

Fluoride is a potent remineralizing agent of the teeth. It is typically applied to the teeth surfaces of patients who are at great risk of tooth decay. Acidulated phosphate fluoride (APF) gel is the most commonly used topical fluoride application agent in dentistry. The gel consists of acid phosphate that etches the enamel on the surface of the tooth. The hydroxyapatite mineral is replaced by fluoride ions to make fluorapatite, which is more resistant against acids produced by the oral flora.<sup>[6]</sup> Fluorides are excellent anticaries agents, they consist of 1.23% of fluoride (F<sup>-</sup>). They help in preventing caries when applied topically.<sup>[7]</sup> Fluorides are extensively used in the field of dentistry in the prevention of caries-prone teeth.<sup>[8]</sup> Topical fluorides are always applied systematically. Oral pathogens such as *Streptococcus mutans* act on calcium apatite crystals, causing demineralization of the calcium crystals by forming a pellicle on the surface of the enamel. Their CA measurement and degree of wettability are necessary to analyze the mechanism in caries prevention and other properties such as how they act on the tooth surfaces.<sup>[9]</sup> Our research and knowledge have resulted in high-quality publications from our team.<sup>[10-24]</sup>

The main aim of this study is to estimate the wettability of topical fluoride gel on the anterior and posterior teeth surfaces.

## MATERIALS AND METHODS

Topical APF gel was taken in small quantities. Anterior and posterior teeth were collected, and their superficial unaltered enamel sections were used as the surface where the CA is determined. The surface wettability is determined using Ossila goniometer to measure CA. Each stage was mounted on a mechanical stage of the goniometer. A calibrated microsyringe was used to dispense drops of the APF gel over the surface of the specimen Group A (anterior tooth cut section) and Group B (posterior tooth cut section). This procedure is repeated for all specimen samples [Figures 1 and 2]. The value of the CA during a measurement is set by performing an inbuilt software-based fitting procedure on every of the recorded pictures and scheming the common of the obtained values [Figure 3]. Totally twenty readings (anterior and posterior cut section) of CA ( $\theta$ ) were taken for ten anterior unaltered enamel sections and ten posterior unaltered enamel sections. The average mean gives the final reading for each specimen. The

measured readings of the anterior and posterior teeth CAs were analyzed using SPSS statistical software.

## RESULTS

The Ossila goniometer was employed in the determination of CA of the topical fluoride gel. The analysis of the CA was performed after placement of the gel on the surface of the tooth substrate, and it was found that the mean CA of anterior teeth (88.41°) was greater when compared to the posterior teeth (80.36°) [Graph 1]. The *P* value was determined using SPSS software's. Chi-square test was found to be 0.271 (>0.05), hence statistically not significant [Table 1].

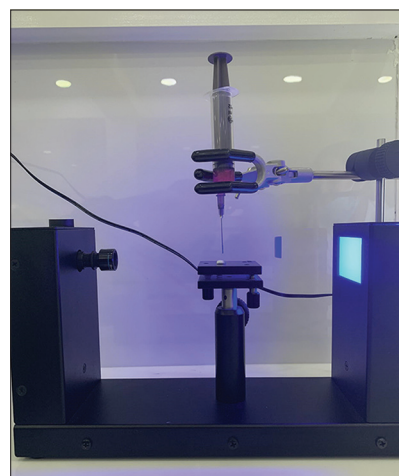
## DISCUSSION

The CA measure technique is perhaps the foremost definitive method of estimation of the CAs of fluids on various surfaces.<sup>[25]</sup> A higher CA results in a lower degree of wettability, and a lower CA has a greater degree of wettability.<sup>[26]</sup> If the CA is >90°, the liquid forms droplets on the solid surface, and if the CA is <90° then the liquid spreads out uniformly on the solid surfaces. Both the CA and the degree of wettability are indirectly proportional to each other. Surface roughness in materials, particle shape, and size of solute particles in solution are all factors

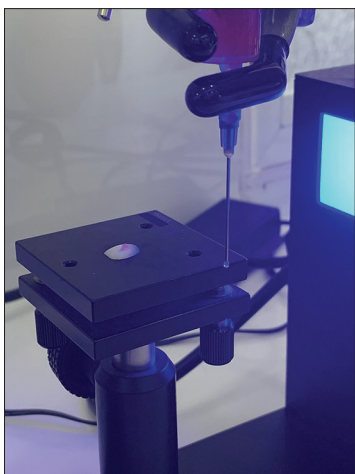
**Table 1: The independent t-test sample for the type of teeth (anterior and posterior) and the mean contact angle**

Groups	n	Mean	SD	Significance
Anterior	10	88.408	9.02	0.271
Posterior	10	80.357	13.07	

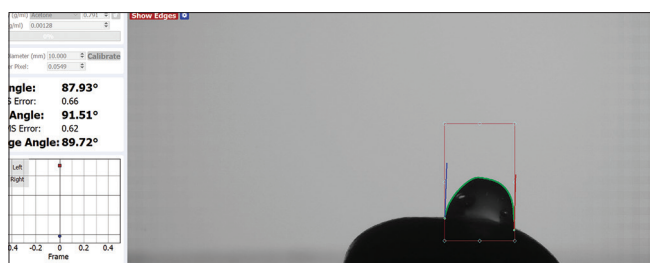
*P* value found using the paired t-test of SPSS software is found to be 0.271 (>0.05), hence statistically not significant. SD: Standard deviation



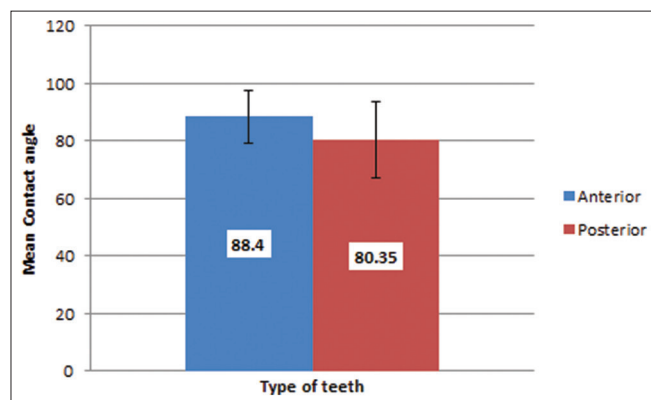
**Figure 1:** The Ossila goniometer, where the anterior teeth are kept for the analysis of the contact angle (wettability) of the topical fluoride gel



**Figure 2:** The Ossila goniometer, where the posterior teeth are kept for the analysis of the contact angle (wettability) of the topical fluoride gel



**Figure 3:** The above figure depicts the analysis of the average contact angle of the topical fluorides on the tooth substrate using the Ossila goniometer



**Graph 1:** The above graph represents the correlation between the type of teeth (anterior and posterior) with the mean of the average contact angle estimated on individual teeth surfaces. The mean of the contact angles of the anterior (88.41°, blue) and posterior tooth (80.35°, red) was found. The mean of the contact angles of the anterior teeth is greater in comparison with the posterior tooth. The anterior teeth have less wettability when compared to the posterior teeth as contact angle is inversely proportional to wettability

that influence the CA. The CA for liquid was found to be particularly high in a study when the substrate was hydrophobic in nature.<sup>[12]</sup> The CA methodology, like other methods, calculates a median price for a property. Surface

topography, physical phenomena of the liquid, surface energy of the substrate, and degree of interaction between the liquid and solid are all factors that must be considered when evaluating CAs.<sup>[27]</sup>

Surface roughness is a component of surface texture, and it is associated with the presence of micro-irregularities associated with the surface.<sup>[28]</sup> Micro troughs and crests are usually associated with surface roughness. They are continuously present on the surface, where the liquids with less CA diffuse.<sup>[29]</sup> The CA is measured with the CA goniometer. The CA goniometer employs a microscopical objective to assess the angle of contact by which the solid surface and the liquid surface come in contact with each. They are used to estimate the spreading coefficient of the liquid.<sup>[30]</sup> In a randomized controlled trial study, it was found that a surface that is rough and dry could alter the wettability of the surface by a greater extent. Teeth surfaces with pores and erosion have greater wettability when compared to smooth surfaces due to the presence of pores where the liquid disperses easily into the surface of the solid.<sup>[31]</sup> In a study, it was found that the wettability depends mainly on the viscosity of the fluid, if the adhesive force exerted by the fluid is high, then the tendency to spread (wettability) is low when compared to the fluids with low viscosity. In a study, the wettability of a surface was analyzed after the surface was coated by Teflon polymers, when Teflon was coated on the surface, the wettability was decreased as the coating was water repellent, and so the degree of wettability was decreased.<sup>[32]</sup> CA (estimation of wettability) of topical fluorides on the teeth surface depends mainly on various factors such as nature/roughness of the solid surface and viscosity of the fluid. Most of the previous research works done were focused on the analysis of the wettability of a surface and other materials by available fluids that were not related to dentistry. Hence, estimation of the CAs is necessary for assessing various properties of the topical fluorides and related changes that occur on the tooth surface where it comes in contact with the fluoride gel. The current study focuses on the estimation of wettability in the teeth surface. The limitations of the current study include less number of the sample size (both the teeth and the APF gel). Other company products and other available topical fluorides can also be assessed in the future.

## CONCLUSION

The mean CA of the topical fluoride APF gel on the anterior tooth surface is greater when compared to the posterior tooth surface. This signifies that greater wettability is seen on posterior tooth surfaces.

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**Conflicts of interest**

There are no conflicts of interest.

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