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Clinical evaluation of wetting angles in gas permeable contact lenses

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Abstract
A clinical evaluation of the wetting angle of six gas permeable contact lenses was made. The wetting angles were measured from actual contact lenses instead of buttons to. better simulate clinical conditions. Each lens was subject to five different conditions. after each condition the wetting angles were measured. We found that five of the six lenses tested had lower wetting angles after being polished than they had coming directly from the lab. The only lens that failed to improve its wetting angle after the polish procedure was the GP II lens.

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CLINICAL EVALUATION OF WETTING ANGLES IN GAS PERMEABLE CONTACT LENSES

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ABSTRACT

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INTRODUCTION

For a number of years the PMMA material was the contact lens material of choice for hard contact lens wearers. PMMA contact lenses have proven to be less than desirable as a contact lens material in the characteristic of oxygen transmissibility. In recent years many PMMA contact lens wearers have developed corneal exhaustion due to prolonged reduction in corneal oxygen. This lens has also been shown to dry out quickly due to its poor wettability. In order to overcome this problem, new technology has been directed toward producing contact lenses that transmit more oxygen and have increased wettability.

The measure of wettability is the contact angle or wetting angle. A drop of liquid on the surface will either spread evenly across the whole surface or it will spread a limited amount, forming a boundary between the liquid and the solid.[1] The wettability is the angle formed by the tangent of the liquid surface compared to the tangent of the solid surface. A material with a wetting angle greater than 90° is said to be hydrophobic ("water hating") while a material with a wetting angle less than 90° is partially wettable. If the wetting angle of the material is 0°, then it is completely hydrophilic ("water loving").[2] The wetting of a contact lens on the eye is important for good vision and comfort. If the contact lens material is not easily wettable, dry areas occur and form beads of water on the surface of the lens.[3]

Some literature and many contact lens manufacturers say that gas permeable lenses wet better than PMMA. Others like Dr. Poster say experimently that gas permeable lens wet better than PMMA, but clinically there are more problems in blurring, hazing, and drying of lens surface in gas permeable than PMMA.[4]

Wetting angle data is widely discussed in the gas permeable lens industry. Each lens manufacturer/distributor is intent on finding a wetting angle measurement which demonstrates their product's competitiveness. An examination of various studies show that numerous methods have been used such as: (1) tilting plate,[5] (2) bubble plate,[6] (3) sessile drop,[7] (4) CMLA method,[8] and (5) Wilhelny Plate method.[6] All of these studies have used flat polished buttons of the contact lens material under strict laboratory conditions. There is a need for information on how wetting angles on gas permeable contact lenses are affected by manufacturing, finishing, and polishing and how these variables affect the actual performance. There is very little research done on wetting angles of gas permeable lenses as it relates to the clinical applications. Our research shows how the wetting angle of contact lenses is affected by: (1) manufacturing, (2) polishing, (3) soaking agents, and (4) protein material.

METHODS

The method we have chosen to measure the wetting angle is the sessile drop method. The sessile drop method entails placing a drop of liquid on a prepared surface and using either a calculated method or a direct protractor measure to arrive at the correct angle. In the past, a horizontal microscope had been used to enlarge the surface/drop image for a more accurate assessment of the angle. Various instruments are now available for direct measurement of the contact angle.

The instrument we have chosen to use in our research is the Kayeness D-1060 Contact Angle Viewer. This instrument has both a protractor overlay for direct readout of the contact angle, as well as a horizontal/vertical dimension scale for using a calculated method.[9] We chose to use the protractor overlay method for direct readout of the contact angle.

In an attempt to standardize the size of the drop placed on the contact lenses, the following procedure was followed. A standard drop height of 600 microns was employed. A two micro-liter drop volume was used, as recommended by Lin and Pinkus.[10]

In order to simulate real life conditions when testing the wetting angles, a decision was made to use contact lens as they come from the lab instead of polished buttons. To minimize surface curvature variables, the contact lenses were ordered in the same power, overall diameter, and base curve. (For specifications see Table 1.)

Table 1

Lens	Power	Overall Diameter	Base Curve
Boston II	-3.00	9.0	8.00
GP II	-3.00	8.8	8.04
Polycon II	-3.00	9.0	8.00
Optacryl	-3.00	9.0	8.00
Paraperm II	-3.00	9.0	8.00
Paraperm O_2	-3.00	9.0	8.00

Five testing procedures were performed sequentially on the six contact lenses. In each procedure the contact lens wetting angle was measured ten times on the convex surface and averaged so that comparison between the procedures was made easier.

Procedure 1: Each lens was taken directly as it came from the lab and the wetting angle was measured.

Procedure 2: The lenses were then polished with x-pal on a sponge strawberry tool for 30 seconds with moderate pressure. The lenses were then cleaned with distilled water and wiped with Kimwipes until visually dry. The wetting angles were then taken again.

Procedure 3: The lenses were placed in Wet and Soak Allergan for twelve days fully immersed. They were then dried with Kimwipes until visually dry and wetting angle determination was again performed.

Procedure 4: The lenses were cleaned with Lobob using a sponge strawberry tool for fifteen seconds with heavy pressure. The wetting angles were again taken.

Procedure 5: The lenses were placed in a .2 percent albumin protein solution in an attempt to simulate wear of the lens by a patient. The lenses were left in this solution for seven days at which time they were wiped with Kimwipes and wetting angles were taken.

Then ten trials from the above five procedures were then averaged to get the mean value under each condition.

Table II

Procedure	1	2	3	4	5
Boston II	93.8	81.4	80.2	80.7	79.3
GP II	55.5	82.2	69.5	72.2	74.1
Polycon II	89.0	83.2	76.8	79.5	75.4
Optacryl	89.1	76.5	81.8	81.4	75.2
Paraperm II	92.9	86.0	78.2	72.6	75.4
Paraperm O_2	86.7	82.0	82.1	74.7	75.4

Two factors contributed to the greater wetting angles than listed by the manufacturers. The angles were measured on a curved lens versus a flat button. Distilled water was used as the drop of liquid rather than other agents. In a study by Walter C. McCrone Association, Inc., it was found that distilled water produced as much as 43^{o} higher wetting angle than wetting solutions.[11]

RESULTS AND DISCUSSION

In procedure one we found the GP II lens to have a considerably better wetting angle than the other five lenses measured. In procedure two where the x-pal was used to polish the lenses the wetting angle improved from 4 to 16 degrees among the different lenses. The only exception to this was the GP II which showed a substantially greater wetting angle after being polished. In procedure three after soaking the contact lenses in Wet and Soak, Polycon II, GP II, and Paraperm II showed an increase in wettability of the lens. Boston II and Paraperm O_2 showed no change and Optacryl decreased in wettability. In procedure four, after polishing the lenses with Lobob, there was no change in wettability with the exception of Paraperm II and Paraperm O_2, which increased in wettability. In procedure five, where the lenses were soaked in the protein solution, Polycon II and Optacryl showed an increase in wetting angle with the other lenses showing no real change.

From the data gathered in our study, we believe there are several conclusions that can be made which will be beneficial to those practitioners using gas permeable contacts in their practice. Our study strongly indicates that these gas permeable contacts from the lab will wet much better if some type of polish series is performed on them prior to dispensing. The GP II lens is the only exception to this rule. This agrees with a study done simultaneously by Normon Goo et al. which found that minor modifications didn't change the wetting angle of the GP II; however, major changes like polishing and edging did.[12]

The other significant finding was that storage of the contact lenses in a soaking agent also improved the wettability of the lenses.

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