

Face and Neck Skin Firmness and Water Content Assessed in Young Women

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Background and Objective

Prior research has suggested a link between skin's mechanical properties and its water content. Such conclusions have generally been based on measurements of stratum corneum (SC) electrical capacitance as an indicator of SC water. Because SC measurements do not include the possible contribution of dermal or hypodermal water to the net skin mechanical properties this aspect of the role of skin water has not been investigated. An understanding and characterization of any such relationships might pave the way for detecting early skin changes that accompany pathological changes or those related to normal age-related changes. We hypothesized that skin hydration, as measured by tissue dielectric constant values (TDC) in upper dermis and deeper, will in fact directly correlate with measures of skin firmness.

Our goal was to test this hypothesis and to additionally provide reference skin water-skin firmness data for subsequent assessments of potential age-related changes.

Methods

All data is expressed as mean \pm SD. Skin water was assessed by tissue dielectric constant measurements (TDC) at 300 MHz to approximate skin depths of 0.5 mm and 2.5 mm on four face sites (A, B, C, D) and two forearm sites (Figures 1 and 2) of 35 healthy female subjects (25.0 ± 1.6 years). TDC values are dimensionless since they are ratios of tissue to vacuum permittivity. For reference, water has a value of 76 at 32° C. The two forearm sites (F1 and F2) are located on the anterior arm 6 cm distal to the antecubital fossa (F1) and 6 cm proximal to the antecubital fossa (F2). Face site A is 2 cm anterior to the tragus, site C is 2 cm lateral and inferior to the commissure of the mouth. Site B is located halfway between sites A and C, while site D is 1 cm lateral and 2 cm superior to the commissure of the mouth. Skin firmness at these sites and at two neck sites (N1 and N2) was determined by measuring the FORCE needed to indent skin 1.3 mm with force in mN. Neck sites N1 and N2 are located 8 cm and 10 cm inferior to face site B, respectively. Regression analysis was used to test the hypothesized inverse relationship between skin firmness and TDC values which are indices of local skin tissue water. Percentages of total body water (TBW) and body fat (TBF) were measured by bioimpedance at 50 KHz (Figure 3) and were $52.5 \pm 5.3\%$ and $28.9 \pm 7.6\%$ respectively. BMI was 22.9 ± 4.1 kg/m². All subjects signed an IRB approved consent form.

Results

FORCE among face sites (Graph 1) varied between 25.2 ± 6.6 mN at site C and 41.0 ± 16.3 mN at site A ($p < 0.001$) with the four site face average being 32.5 ± 7.2 mN. Average FORCE at neck and forearm were 28.3 ± 8.3 and 60.2 ± 18.6 mN with arm FORCE significantly greater than face or neck ($p < 0.001$). TDC varied by face site and depth. At 0.5 mm site (Graph 2) A had the greatest value (40.2 ± 5.3) and site B the least (31.4 ± 8.5 , $p < 0.001$) with sites C and D being nearly equal (36.8 ± 6.2 vs. 36.5 ± 5.7) and an overall average among sites of 36.2 ± 4.9 . Contrastingly, at 2.5 mm (Graph 3) the greatest values were at sites C (39.9 ± 5.7) and D (39.4 ± 5.3) which were significantly ($p < 0.001$) greater than A (35.9 ± 4.7) and B (35.7 ± 4.2). The overall average of the four face sites was 37.7 ± 4.4 . Forearm average TDC values were significantly less ($p < 0.001$) being 32.0 ± 4.2 and 27.0 ± 4.1 for 0.5 and 2.5 mm depths respectively. Regression analysis showed a small correlation between face and forearm FORCE ($R = 0.360$, $P < 0.05$), a significant ($P < 0.001$) correlation between face and forearm TDC values but no significant correlation between FORCE and TDC values at face or forearm.

Measurements Illustrated

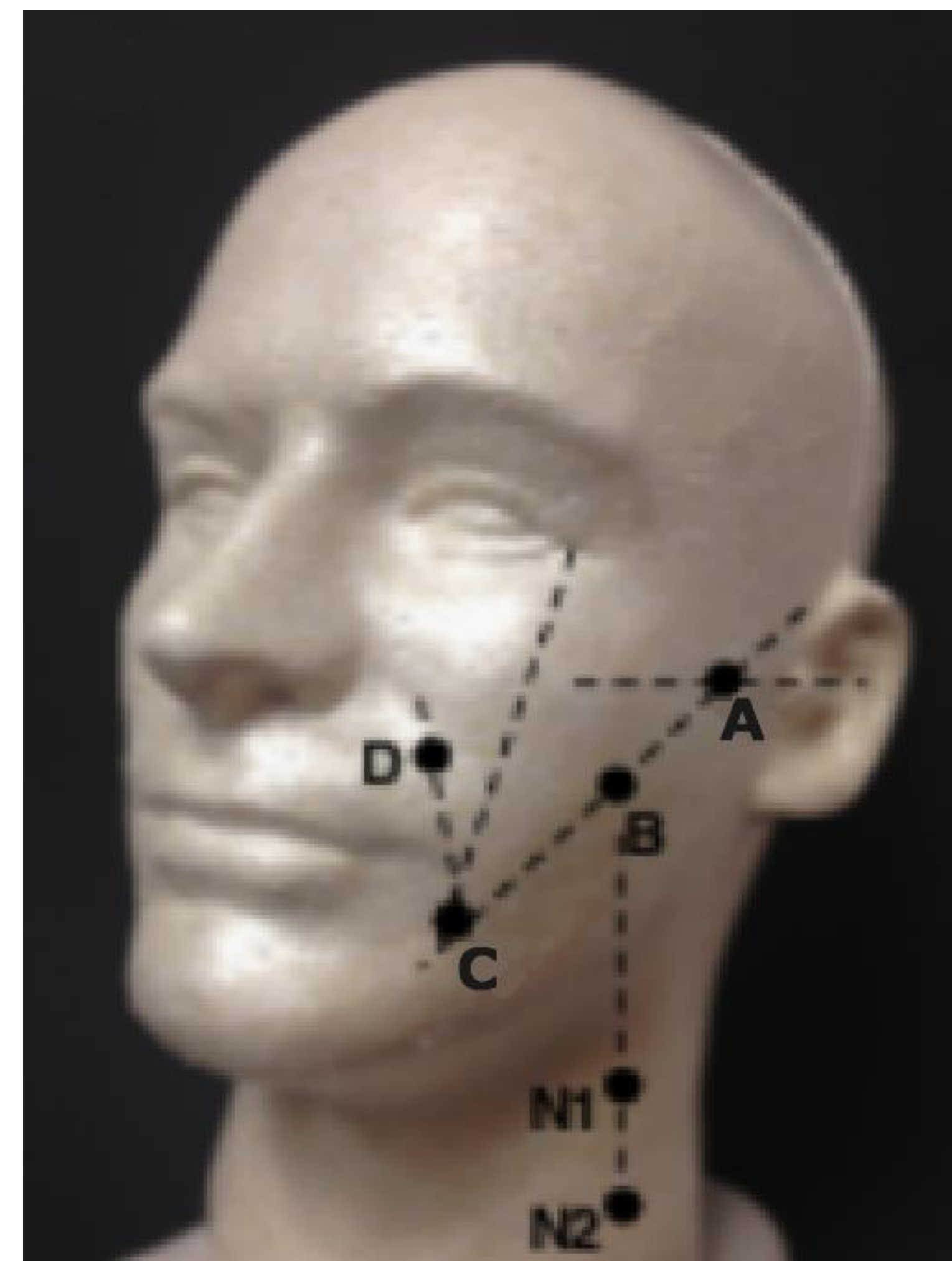


Figure 1. Neck and Face Sites

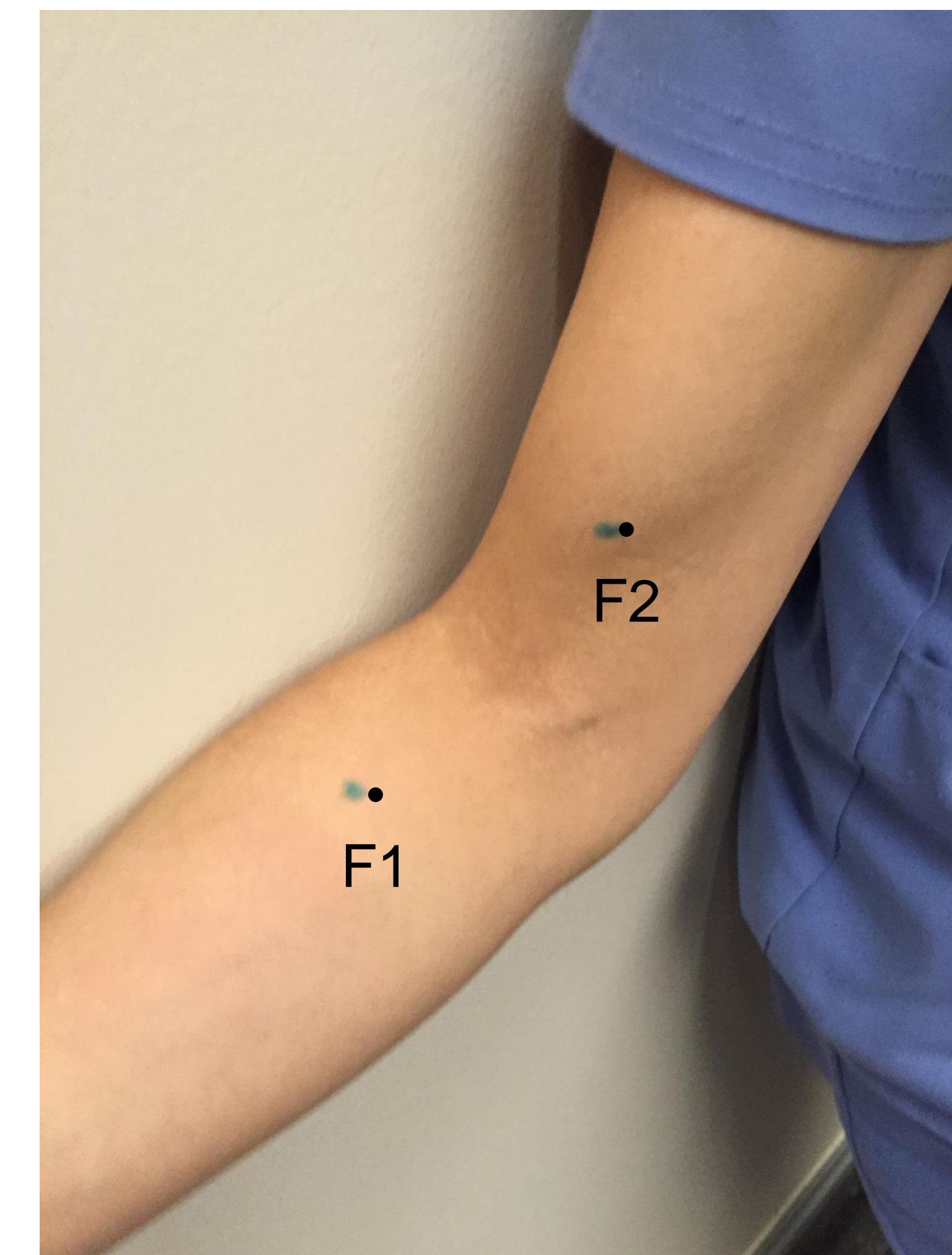


Figure 2. Forearm Sites



Figure 3. Bioimpedance Scale

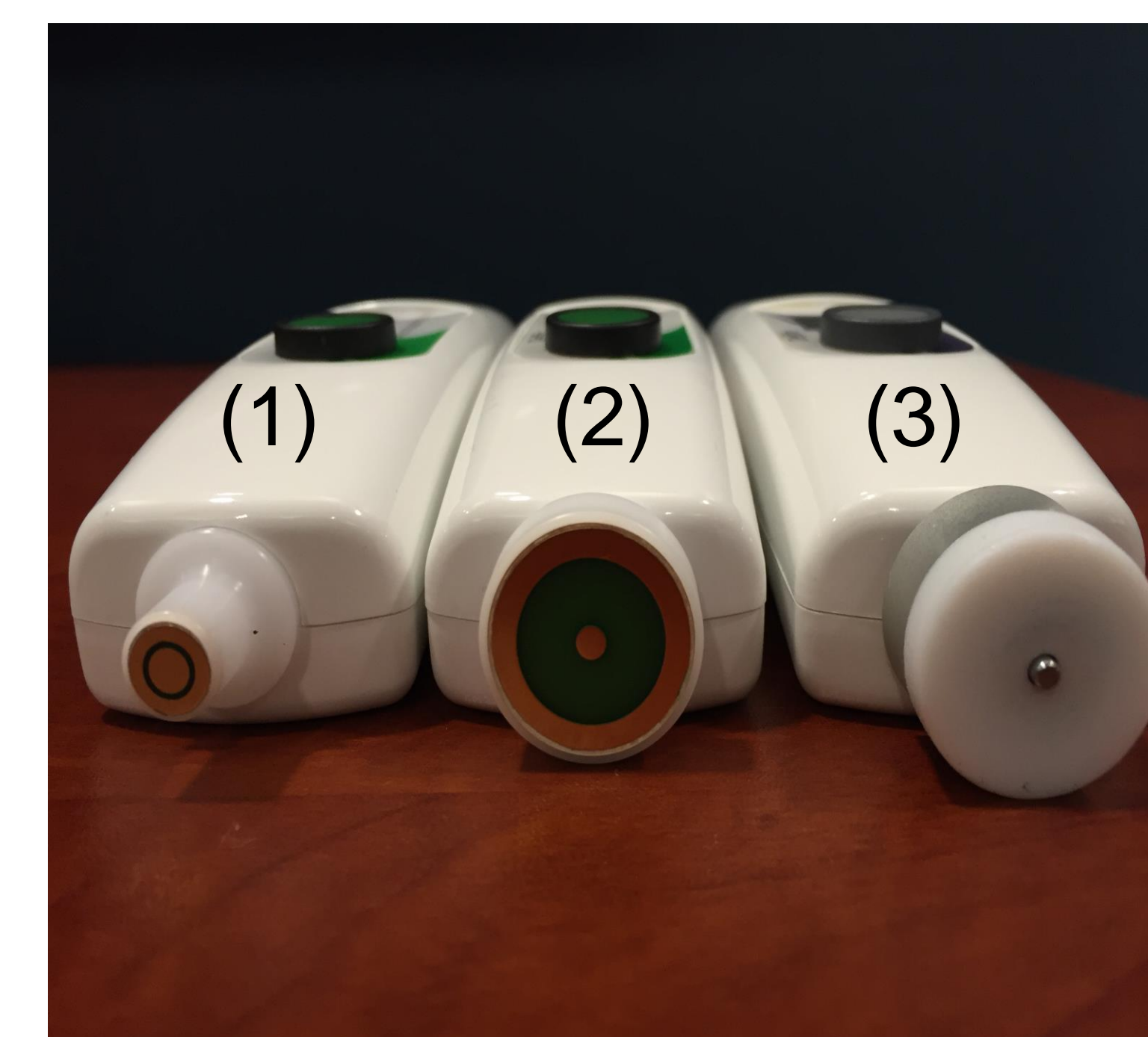
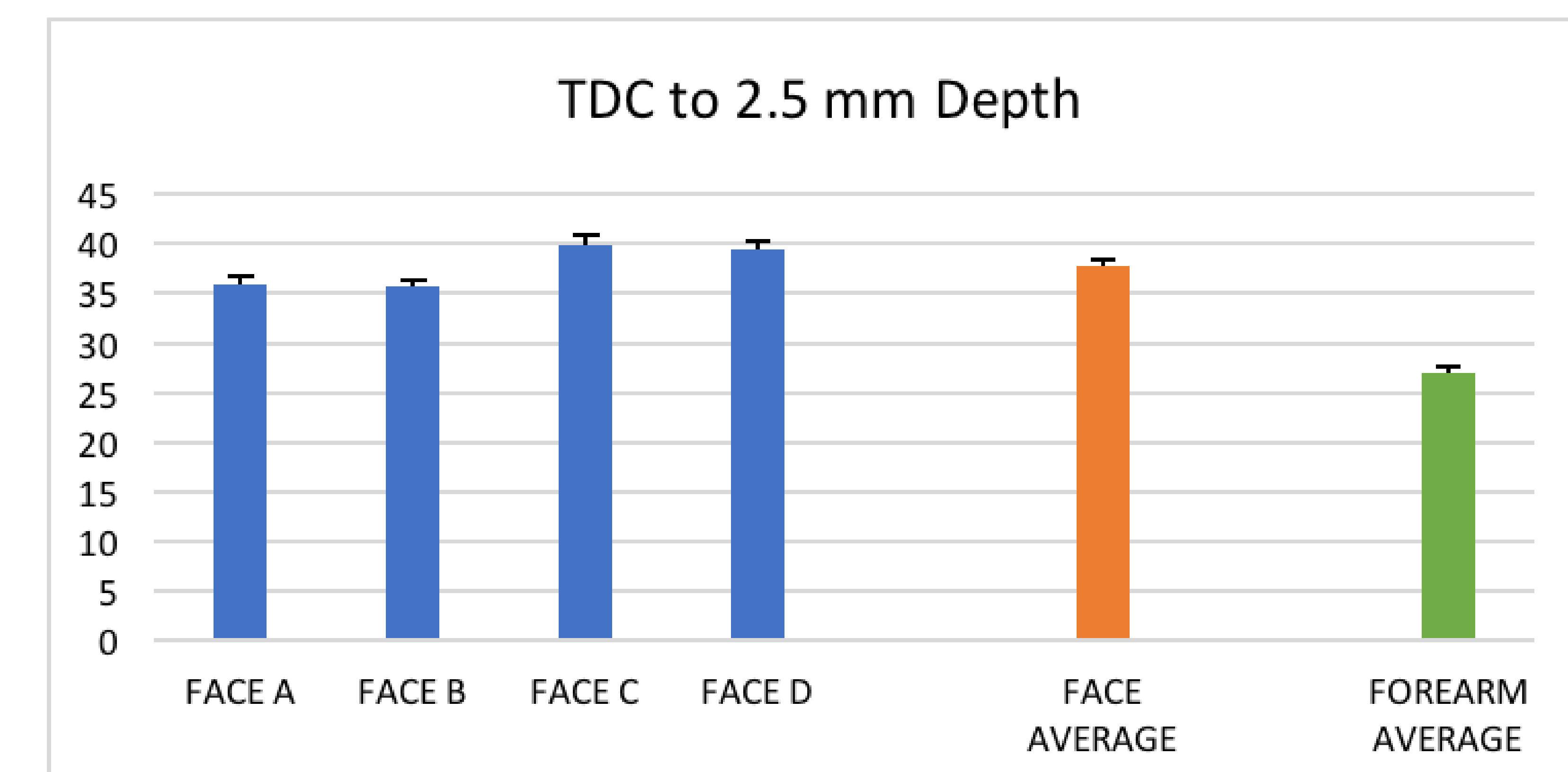
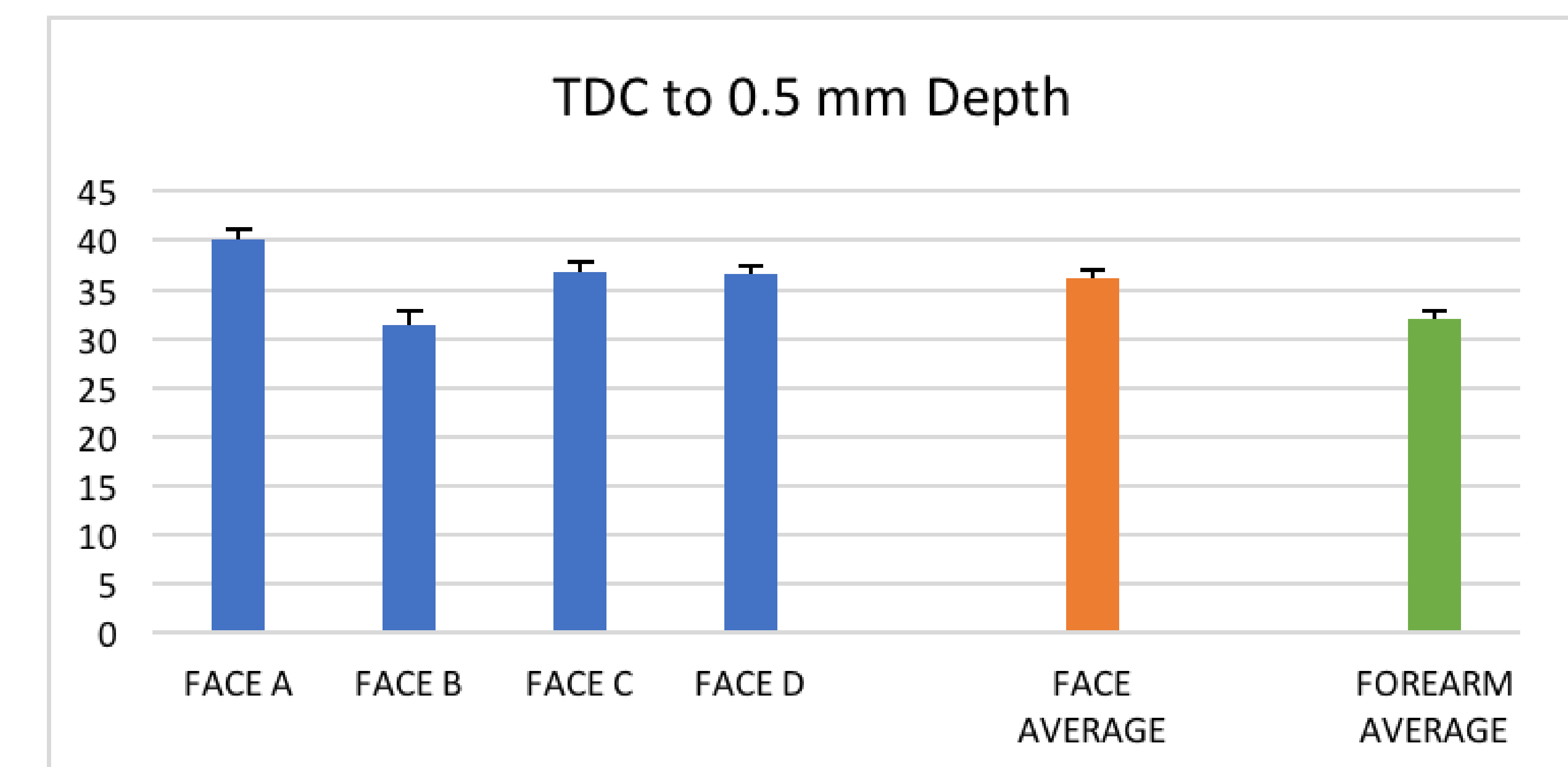
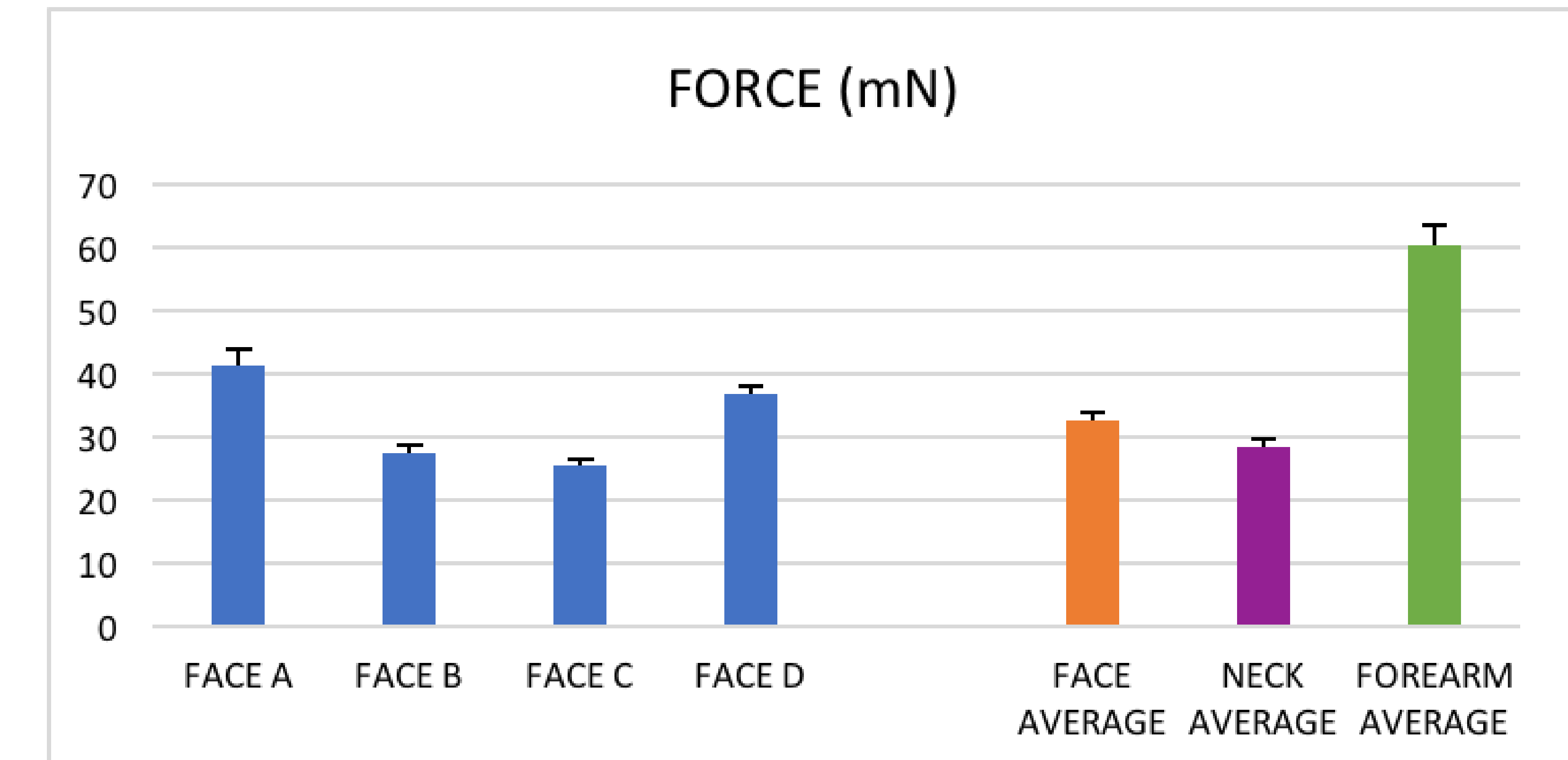


Figure 4. Skin Measurement Devices
All manufactured by Delfin Technologies Kuopio, Finland
(1) TDC to a depth of 0.5 mm
(2) TDC to a depth of 2.5 mm
(3) Fibrometer – Indentation Force

Main Outcomes



*Error bars represent the Standard Error of the Mean.

Conclusions

Results do not demonstrate a significant skin water-skin firmness relationship at the studied skin sites and are thus inconsistent with the initial hypothesis. However, the skin firmness and TDC data for face, neck and forearm for this young female group provides reference data for subsequent comparisons of possible age and skin-related therapeutic affects.