Estimating Maxillary Sinus Dimensions Using Smartphone Camera

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***Abstract*— This study investigates the feasibility of estimating maxillary sinus dimensions using a smartphone camera. Twenty-eight individuals underwent Computed Tomography (CT) and phone-camera face scans, revealing a high degree of agreement between the two methods. This provides a promising foundation for incorporating smartphone technology into clinical practice.**

***Clinical Relevance*— Innovative, non-invasive approach with potential applications in assessing sinus conditions and providing remote diagnostic options.**

I. INTRODUCTION

The maxillary sinus, an essential component of the human sinonasal system, plays a vital role in respiratory function, immune support, voice resonance, and head injury protection. Accurate diagnosis and effective management of sinus conditions require a comprehensive understanding of sinus anatomy.

Drawing inspiration from craniofacial superimposition techniques [1], we introduce a novel method correlating facial landmarks with maxillary sinus dimensions using an iPhone's infrared front-facing camera. This approach could potentially reduce radiation exposure and healthcare costs associated with the excessive use of Computed Tomography (CT) scans, offering a promising alternative for patient care.

II. METHODS

We recruited 28 eligible participants who underwent a full CT scan of the sinuses and a Face scan with the Apple iPhone's front-facing camera.

CT scans were conducted using the Xoran MiniCAT scanner. We measured the maximum width and height of both left and right maxillary sinuses, as shown in Fig. 1. Two independent reviewers performed the CT measurements, and their average was used for analysis.

For Face Scans, we utilized Apple's ARKit framework [2] that creates a 1220-dot 3D mesh model of the user's face, enabling us to estimate the same dimensions using fixed craniofacial landmarks. We chose ARKit points with maximum point density around key landmarks, invariant to adipose tissue layers, and calculated their 3D vector distances.

III. RESULTS

We evaluated the agreement between CT and Face scan measurements for estimating maxillary sinus dimensions. We calculated absolute and percent errors between these measurements. The absolute error, representing the difference between CT and Face scan values, was 0.139 ± 0.084 cm (mean ± standard deviation) for width and 0.252 ± 0.191 cm for height. The percent error for width was 4.13 ± 2.44 %, and for height, it was 6.38 ± 4.79 %. These results demonstrate a high degree of agreement between the two methods and reinforced our choice of ARKit mesh points.

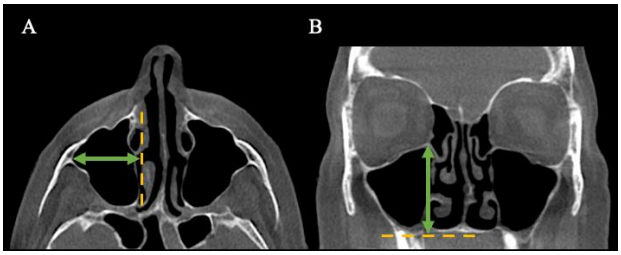

Figure 1. Example of CT measurements for width (A) and height (B) of the right maxillary sinus.

TABLE I. ERRORS BETWEEN CT AND FACE SCAN MEASUREMENTS

	Width	Height
Absolute Error	0.139 ± 0.084 cm	0.252 ± 0.191 cm
Percent Error	4.13 ± 2.44 %	6.38 ± 4.79 %

IV. DISCUSSION & CONCLUSION

Facial features can provide valuable insights into internal structures and functionalities. Reverse engineering this concept by leveraging this technology alongside the patient's history and physical examination paves the way for more efficient diagnosis and treatment options. Our study's limitations include small sample size and reliance on a single front-camera scan with iOS-compatible technology. Further research should assess the feasibility of using multiple scans at various angles and quantifying other paranasal sinuses and structures. In conclusion, this pioneering use of smartphone technology for assessing anatomical dimensions marks a promising new direction for telemedicine and enhanced patient care.

REFERENCES

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