A Novel Technique for Malar Eminence Evaluation Using 3-Dimensional Computed Tomography

Sami P. Moubayed, MD; Frederick Duong, MD; Christian Ahmarani, MD, FRCSC; Akram Rahal, MD, FRCSC

Objective: To describe a novel method to locate the malar eminence using 3-dimensional computed tomography (3D-CT), and a new axis system for evaluation of malar eminence symmetry.

Methods: A retrospective case series was carried out in 42 disease-free white adult patients. The 3D-CT reconstructions of the face were obtained, and the soft-tissue maxillozygion was used to locate the malar eminence. Other skeletal and soft-tissue landmarks (frontozygomatic suture, zygion, and orbitale) were evaluated. A patient-oriented axis system was constructed using 3 sagittal midline landmarks (nasion, subspinale, and basion). Coordinates were obtained for each landmark, and symmetry was evaluated.

Results: Twenty-one men and 21 women with mean ages of 41.1 and 41.3 years, respectively, were included. The malar eminence was easily localized using the 3D-CT technique for soft-tissue maxillozygion identification. Clinical asymmetry at the level of the soft-tissue maxillozygion was 40.5% (95% CI, 25.0%-56.0%). Other landmarks showed a prevalence of clinical asymmetry ranging from 24.0% to 50.0%.

Conclusions: The malar eminence can be easily and precisely located using the 3D-CT soft-tissue maxillozygion landmark. A reliable patient-oriented axis system can be defined using nasion, subspinale, and basion. The prevalence of malar eminence asymmetry in our study was 40.5%.


The malar eminence is defined as the most prominent portion of the zygomaticomaxillary complex.\(^1\) It dominates the lateral midface, defines cheek projection and contour, and has an important role to play in ocular globe position and in mastication.\(^2\) It is of surgical interest in facial trauma and aesthetic surgery because the zygoma is the second most frequently fractured facial bone,\(^3\) and the midface is the center of the gaze in humans, rendering it crucial for judgments of symmetry.\(^4\)

Objective facial analysis is essential for preoperative planning and postoperative evaluation. Several techniques have been described to precisely locate the malar eminence using intersecting lines.\(^5\) A major drawback of these techniques is that 2-dimensional (2D) lines are used to locate a 3-dimensional (3D) structure. A more reliable technique using palpation was described by Nechala et al\(^6\) and consists of identifying a landmark termed the maxillozygion. The maxillozygion is localized at the most prominent point on the maxillozygomatic suture line below the lateral third of the bony orbit.

Initial facial assessment includes evaluation of symmetry. However, traditional techniques for evaluation of malar symmetry, whether by palpation, photometry, or cephalometry, are subject to distortion due to structure overlap, magnification, and dependence on the patient’s head position.\(^7\) Techniques using 3D computed tomography (3D-CT) provide actual measurements, spatial 3D image production, ability to change the rotational axis, and independent observation of organs and structures.\(^8\)

However, to our knowledge, no technique has been described to identify the malar eminence using 3D-CT to evaluate its symmetry. In this study, we describe a novel method to locate the malar eminence using 3D-CT and a new axis system to evaluate its symmetry.
METHODS

We conducted a retrospective case series at our hospital center. We included white patients older than 18 years who had had a CT scan of the face in the past 2 years. We selected patients to obtain a proportional age distribution. We excluded patients with history of craniomaxillofacial trauma, deformity, or surgery, including sinus surgery. Moreover, no craniomaxillofacial abnormality or asymmetry was detected on the scans by the radiologist.

The CT scans were acquired using a General Electric LightSpeed VCT scanner (spiral acquisition, 1.25-mm pitch, 120 kV). The console used to reconstruct the scans in 3 dimensions was a General Electric AW2. A volume-rendering technique was used to create the 3D images. Both skeletal and soft-tissue reconstructions were available. Using the reporting tool, we visually selected the appropriate landmarks on the volume rendering viewpoint (3D model). The axial, sagittal, and coronal views were used to confirm correct placement of the landmarks. The 3D model was rotated to give us the best possible angle to assert the location of our marker. All measurements were taken in triplicate by the same observer (F.D.). The mean (SD) values for each landmark were calculated and used for further analysis.

For precise and reproducible localization of the maxillozygion, a 3D reconstruction view was obtained and looked at from a superior three-quarters view. The most prominent point on the zygoma below the lateral third of the orbit was identified and selected (Figure 1A). The position of this point was then verified as being the most anterior on 2D axial, coronal, and sagittal views (Figure 1B-D, respectively). The soft-tissue maxillozygion was obtained using the anterior projection of the skeletal maxillozygion.

Other identified landmarks included the frontozygomatic suture (the most anterior point of frontozygomatic suture on the orbital rim), the zygion (the most lateral point on the zygomatic arch), and the orbitale (the lowest point on inferior orbital rim). The soft-tissue projections of these landmarks were also identified. These landmarks are represented in Figure 2.

Three skeletal landmarks were used to produce a patient-oriented axis system: the nasion (the point of nasofrontal suture on the sagittal midline), subspinale (the most posterior point of the alveolar process on the sagittal midline), and the basion (the most anterior and inferior point on sagittal midline of foramen magnum). Using these landmarks, we developed a patient-oriented axis system centered at the nasion to compensate for the patient’s head position.

The y-axis is the line passing through the nasion and subspinale. The z-axis is the projection at the nasion of a line passing through the y-axis and the basion. Finally, the x-axis is a line perpendicular to the y- and z-axes at the nasion. The axis system is represented in Figure 3. An open source program developed at the 3D Vision Laboratory at the Université de Montréal provided patient-oriented coordinates for each landmark according to this reference system.

The spatial positions for all landmarks were compared between the right and left sides of the patient’s face using a t test.

Figure 1. The 3-dimensional (3D) computed tomographic localization of maxillozygion. The skeletal maxillozygion (arrows) is identified as the most anterior point on the maxillozygomatic suture line below the lateral third of the orbit. It is identified on 3D reconstruction (A) (arrows), axial view (B) (asterisks), coronal view (C) (asterisks), and sagittal view (D) (asterisk).
We used the absolute values for the coordinates on the x-axis. The proportion of patients showing clinical asymmetry was noted for each landmark.

Clinical asymmetry was defined as at least a 2-mm difference in any axis. According to the literature, this difference can be detected by an experienced clinician 50% of the time.9

**RESULTS**

The patient distribution according to sex and age is presented in Table 1. The mean (SD) age for men is 41.1 (13.6) years and for women is 41.3 (15.5) years. The mean differences between skeletal and soft-tissue landmarks in all axes are presented in Table 2.

<table>
<thead>
<tr>
<th>Age, y</th>
<th>Male (n = 21)</th>
<th>Female (n = 21)</th>
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</thead>
<tbody>
<tr>
<td>18-29</td>
<td>5</td>
<td>5</td>
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<tr>
<td>30-41</td>
<td>7</td>
<td>6</td>
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<tr>
<td>42-53</td>
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<td>54-65</td>
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</tr>
<tr>
<td>Mean (SD)</td>
<td>41.1 (13.6)</td>
<td>41.3 (15.5)</td>
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</table>

According to our definition of clinical asymmetry, the prevalence of clinical asymmetry for the soft-tissue maxillozygion is 40.5% (95% CI, 25.0%-56.0%). All points presented a prevalence of asymmetry ranging from 24.0% (95% CI, 10.0%-36.0) to 50.0% (95% CI, 34.0%-66.0%). The asymmetry prevalence for individual points is presented in Figure 4.

To our knowledge, this is the first study in the literature to localize the soft-tissue maxillozygion using 3D-CT. Initially described for localization by palpation,6 the soft-tissue maxillozygion can be easily localized using a 3D-CT reconstruction model by identifying the skeletal landmarks.

The identified prevalence of soft-tissue maxillozygion in our study (40.5%) is similar to the prevalence identified in the initial study by Nechala et al.6 Depending on the reference point used to evaluate symmetry, maxillozygion asymmetry rates ranged from 29.7% to 40.5% (vertex, opisthocranion, tragion).6 Using a very

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**COMMENT**

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TABLE 1. Patient Age and Sex Distribution

<table>
<thead>
<tr>
<th>Age, y</th>
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<th>Female (n = 21)</th>
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some axis systems do not correlate with visible facial asymmetry.6 Some axis systems do not correlate with visible facial asymmetry.6 Some axis systems do not correlate with visible facial asymmetry.6 Some axis systems do not correlate with visible facial asymmetry.6 Some axis systems do not correlate with visible facial asymmetry.6

Table 2. Mean (SD) Difference Between Landmark Localization on 3-Dimensional Computed Tomography

<table>
<thead>
<tr>
<th>Axis</th>
<th>FZS</th>
<th>Zygion</th>
<th>Orbitale</th>
<th>MZ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>x</td>
<td>y</td>
<td>x</td>
<td>y</td>
</tr>
<tr>
<td></td>
<td>0.89 (0.57)</td>
<td>1.20 (0.85)</td>
<td>1.49 (1.32)</td>
<td>1.12 (0.82)</td>
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<tr>
<td></td>
<td>1.76 (1.41)</td>
<td>2.25 (1.49)</td>
<td>1.30 (1.01)</td>
<td>1.81 (1.25)</td>
</tr>
<tr>
<td></td>
<td>1.37 (1.10)</td>
<td>1.89 (1.69)</td>
<td>1.35 (1.15)</td>
<td>1.35 (1.01)</td>
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<td>1.22 (0.91)</td>
<td>1.62 (1.76)</td>
<td>1.31 (0.98)</td>
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<tr>
<td></td>
<td>2.42 (1.78)</td>
<td>1.27 (1.04)</td>
<td>1.93 (1.35)</td>
<td></td>
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<tr>
<td></td>
<td>2.11 (1.90)</td>
<td>1.11 (0.83)</td>
<td>1.38 (1.03)</td>
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Abbreviations: FZS, frontozygomatic suture; MZ, maxillozygion.

In conclusion, the malar eminence can be easily located using the 3-D-CT soft-tissue maxillozygion landmark. A reliable, patient-oriented axis system can be defined using the landmarks nasion, subspinale, and basion. In our study, the prevalence of malar eminence clinical asymmetry using the soft-tissue maxillozygion reference point is 40.5%.

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Correspondence: Akram Rahal, MD, FRCSC, Otolaryngology–Head and Neck Surgery Service, Department of Surgery, Hôpital Maisonneuve-Rosemont, RT-1148, Pavillon J. A. DeSève, 1er étage, 5415 Blvd De l’Assomption, Montréal, QC H1T 2M4, Canada (akram.rahal@umontreal.ca).

Author Contributions: Study concept and design: Moubayed, Duong, Ahmarani, and Rahal. Acquisition of data: Duong and Rahal. Analysis and interpretation of data: Duong, Ahmarani, and Rahal. Drafting of the manuscript: Moubayed, Duong, and Ahmarani. Critical revision of the manuscript for important intellectual content: Rahal. Statistical analysis: Moubayed and Duong. Administrative, technical, and material support: Rahal. Study supervision: Ahmarani and Rahal.

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REFERENCES