Computer-Aided Assessment of Bony Nasal Pyramid Dimensions

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Objective: To develop a computer-enabled paradigm for assessment of bony nasal pyramid dimensions.

Design: Retrospective review of archived computed tomographic data.

Setting: Tertiary level academic center.

Patients: Patients who had undergone computed tomographic scans for computer-aided transsphenoidal hypophysectomy were included. Previous nasal surgery, inflammatory sinus disease, and documented maxillofacial trauma were exclusion criteria.

Intervention: Archived computed tomographic scan images were reviewed using the software tools on a computer-aided surgical (CAS) system (StealthStation; Sofamor Danek, Memphis, Tenn). Standardized methods for the measurement of nasal bone thickness and bony nasal pyramid projection were established.

Main Outcome Measurements: Bony nasal pyramid projection and nasal bone thickness were determined.

Results: Computed tomographic scans from 8 patients were reviewed. Nasal bone thickness at the level of lateral osteotomy was 2.39±0.68 (mean±SD) mm, while nasal bone thickness at the level of intermediate osteotomy was 1.18±0.30 mm. Nasal projection from the nasomaxillary suture to the rhinion in the axial plane was 19.20±3.10 (mean±SD) mm, while the corresponding nasal projection at the nasion was 20.61±3.52 mm.

Conclusions: This brief report presents a new paradigm for the assessment of the bony nasal pyramid. Additional normative data are necessary. This information has important implications for rhinoplasty instrument design, surgical planning, and aesthetic assessment. It is likely that computer-enabled review of archived computed tomographic images for maxillofacial assessment will become increasingly accepted. Of course, further modifications of computer technology and its specific applications are expected.


Because the nose is a central feature of facial appearance, facial plastic surgeons need techniques for the assessment of nasal proportions. Direct clinical examination provides critical information, but this approach suffers from a lack of standardization. Therefore, other strategies, including plain x-ray cephalometrics,1 have been introduced. Also, numerous mathematical formulas that relate physical measurements of specific anatomic features have been proposed.

Over the past decade, computer-aided surgical (CAS) systems, which provide precise 3-dimensional (3D) localization during various neurosurgical and otorhinolaryngological procedures, have been introduced. Typically, these computer systems assign a 3D coordinate system to preoperative computed tomographic (CT) scan data, and the software packages include specific software for surgical planning. Although not optimized for routine analysis of CT images, such systems can be applied for this purpose.

This report describes a pilot project that uses a novel application of computer-enabled review of archived CT data to quantify important features of the bony nasal pyramid.

RESULTS

Computed tomographic scans from 8 patients were reviewed. This group included 3 men and 5 women. Their mean±SD age was 37.5±20.4 years. Six of the patients were white and 2 were African American.

The mean±SD lateral osteotomy nasal bone thickness was 2.39±0.68 mm. The
PATIENTS AND METHODS

Patients were selected from a CT image data archive of all patients who had undergone computer-aided otorhinolaryngologic procedures during 1998. In this study, all patients underwent a preoperative CT scan for surgical navigation for transsphenoidal hypophysectomy. Specific exclusion criteria included documented maxillofacial trauma, known congenital anomalies, and previous nasal surgery. Paranasal sinus opacification was staged using the system described by Lund and Kennedy,2 and only patients with a score of 0 were included.

Archived CT data were transferred to a CAS computer (StealthStation; Sofamor Danek, Memphis, Tenn) for review. One of 2 commercially available software packages (Stealth Cranial 2.6.4 [Sofamor Danek] or LandMark 2.6.4 [Xomed, Jacksonville, Fla]) was used. It should be noted that both software packages are almost identical, except for relatively minor differences in the user interface. Although the StealthStation is designed for surgical navigation during neurosurgical, spine, and ear, nose, and throat surgery, its software includes many specific features that facilitate analysis of both CT and magnetic resonance images. These software tools include (1) 3D models, (2) various “cut” views, (3) a 3D coordinate system, (4) image magnification, and (5) distance-measuring tools. These features were used in our study.

For each CT data set, a standardized review was performed. A 3D model of the craniofacial skeleton was created. The axial images were reviewed to ensure that the scanning plane was parallel to the Frankfort line. Axial, coronal, and sagittal images, as well as the 3D model, were all reviewed to determine the location of the rhinion (Figure 1) and nasion (Figure 2). The superior-inferior coordinate for the axial plane for each of these points was recorded. The right-left coordinate for the midline sagittal plane was also noted.

Nasal bone thickness was then assessed in the axial plane through the rhinion. First, the nasomaxillary suture was identified. The surgical planning distance measurement tool was then used to measure the nasal bone thickness at this point. This was termed lateral osteotomy nasal bone thickness (Figure 3). A similar measurement was made at a point halfway between the rhinion and the nasomaxillary suture. This was called the intermediate osteotomy nasal bone thickness (Figure 4). Separate measurements were made for each side.

Nasal projection at the axial planes through the rhinion and nasion was examined. Distance measurement tools determined the distance from the nasomaxillary suture to the rhinion. This measurement was known as the rhinion nasal projection (Figure 5). An imaginary line was then drawn through the nasomaxillary suture and perpendicular to the axial plane. The distance from this line to the nasion in the axial plane was then measured. This measurement was labeled the nasion nasal projection (Figure 6). Again, separate measurements were made for each side. Standard statistical analysis was completed.

COMMENT

This preliminary study presents a unique perspective on the assessment of the bony nasal pyramid. Traditionally, direct inspection has provided the means for clinical assessment of nasal structure. Of course, cephalometrics, which relies on standardized measurements of plain lateral x-ray films, have also been used for this purpose.1 Technology for computer-assisted review of radiographs for cephalometric analysis has also been developed.3 In our study, archived CT data were reviewed on a computer workstation for image analysis.

To permit meaningful measurements, standard parameters of nasal dimensions were adapted. Computed tomographic scans provide specific planar information that is distinct from standard inspection of nasal appearance and plain x-ray films. Also, the specific software tools in the StealthStation software packages have unique features that mandate modifications from plain-film cephalometrics. For these reasons, 2 parameters of nasal projection (ie, rhinion nasal projection and nasion nasal projection) were defined.

Admittedly, this series contains measurements from a limited pool of patients. Of course, normative data for these measurements would require review of a larger number of CT scans. Such data are readily available, and because the measurements are obtained on a computer workstation, the measurements should not present significant logistical problems.

Interestingly, the nasion nasal projection measurements were consistently greater than the rhinion nasal projection measurements. The relatively greater nasion projection measurements compared with the rhinion projection measurements can be accounted for by the nasion measurement vector, which extended from the nasomaxillary suture at the bony piriform aperture. Because this vector is diagonal, the nasion nasal projection measurements were statistically greater than the rhinion nasal projection measurements. The relatively greater nasion projection measurements compared with the rhinion projection measurements can be accounted for by the nasion measurement vector, which extended from the nasomaxillary suture at the bony piriform aperture. Because this vector is diagonal, the nasion nasal projection measurements were statistically greater than the rhinion nasal projection measurements.
surement provides a composite measure of the anteroposterior bony projection at the nasion and the length of the bony pyramid. In contrast, the rhinion projection measurement represents an anteroposterior measurement only.

The anteroposterior nasion projection is normally smaller than the anteroposterior rhinion projection owing to the wider excursion of the nasal bones in its distal portion. It is important to clarify that the nasion projection measurements in this study include not only an anteroposterior measurement, but also an inferosuperior component. Although this provides some additional information (i.e., bony nasal length), the nasion and rhinion projection measurements should not be compared directly in a relative fashion.

The nasion projection measurements for African American subjects were relatively greater than for white subjects. This observation may be attributable to a greater anteroposterior projection or longer nasal bones. It would be interesting to assess this relationship using greater subject numbers, since one limitation in this study is the small number of African American subjects.

Computer-enabled review of the bony nasal skeleton offers several distinct advantages. As already stated, a large potential data pool already exists. Also, review of the data at locations that are remote from their acquisition point is possible, since only a computer workstation, as well as the images, is necessary. Finally, this paradigm of “virtual dissection” on a computer workstation has certain intrinsic features that other media (e.g., cepha-
metrics or visual inspection) cannot duplicate. For instance, simultaneous review of axial, coronal, and sagittal images and the 3D reconstruction provides a 3D perspective of both surface appearances and underlying architecture. In this project, the impact of this advantage is not completely apparent; however, other pending projects that assess facial projection relative to skull base landmarks capitalize on these features.

The paradigm for computer-based CT analysis has limitations. Familiarity with the computer software is essential, and a clear learning curve in its use is present. Also, the software for this project was somewhat cumbersome, since it was not specifically designed for this type of application. Finally, the clinical impact of the perspective afforded by this type of analysis is unclear.

Despite these disadvantages, it is likely that computer-aided review of CT scan images is likely to become more widely accepted. Computer software and hardware improvements are anticipated, and further clinical experience will drive additional modifications of these initial efforts.

Computer-aided assessment of the bony nasal pyramid has many potential applications. This approach provides a quantitative way to reliably assess the bony nasal pyramid. Such quantitative data would be useful for tracking maxillofacial growth. Contiguous assessment of nasofacial development is warranted in cases of congenital and acquired pediatric craniofacial anomalies, where it is necessary to closely track the skeletal growth in specific facial regions. The software tools can be used to con-
veniently and accurately measure nasofacial dimensions from the CT scan data. It is important to remember the controversies that surround nasal, sinus, and midfacial surgery and facial growth. The surgical effects on midfacial growth may also be tracked with this technique. Computer-aided, CT-based cephalometrics can potentially help to clarify what, if any, changes in midfacial growth occur with antecedent surgery in the region. Reliable skeletal reference points can provide a meaningful method for comparison of nasofacial growth in a surgical group with that in a normative group. The novel technique described herein offers a new perspective on assessing normal craniofacial proportions.

Furthermore, computer-derived CT measurements may be of great benefit in planning complex craniofacial reconstructive procedures. Normative values for pediatric and adult patients, as well as for specific ethnic populations, may provide helpful guidelines for reconstruction. For instance, computer-aided CT review may provide information for the estimation and/or confirmation of optimal thickness of nasal augmentation and nasal projection. This information also may prove useful in determining the ideal sites for hardware fixation device placement.

Nasal bone thickness was also directly assessed. A recent cadaveric study reported similar data. Such measurements have important implications for the design of osteotomes for osteotomies performed during rhinoplasty procedures (Daniel Becker, MD, oral communication, January 1999). Also, nasal bone thickness influ-

Figure 5. The distance between the points (indicated by circles) demarcates the rhinion nasal projection. The points were chosen as described in the “Patients and Methods” section.

Figure 6. The distance between the points (indicated by circles) demarcates the nasion nasal projection. The points were chosen as described in the “Patients and Methods” section.
ences actual fracture patterns produced by lateral and intermediate osteotomies. In turn, this type of information may also prove useful in aesthetic surgery.

**CONCLUSIONS**

Computer-enabled review of CT scans offers a unique perspective on clinically relevant parameters of the maxillofacial skeleton. In this study, a CAS system was used to review archived CT scans for an assessment of the bony nasal pyramid. Nasal bone thickness measurements at the levels of the lateral and intermediate nasal osteotomies were performed. Also, CT-defined parameters of the nasal bony pyramid projection were developed. Although this report focuses on preliminary data, the described paradigm (with modifications that reflect future experiences) will garner wider acceptance as surgeons become familiar with computer-based image analysis and as these software programs undergo further development.

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**REFERENCES**