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Nose approximation from Cone-Beam Computed Tomography (CBCT) scans using a new computer-assisted method based on automatic landmarking.

Content

Manual facial reconstruction methods require a high degree of anatomical and sculptural expertise and remain difficult and inherently subjective in practice. Additionally, the non-consideration of population specificities, the lack of standardisation and the poor correlations between facial bony structures and facial soft features, also limit objectivity and accuracy of manual reconstructions. In light of a great demand for the identification of unknown remains in South Africa, a need exists to establish reliable facial approximation techniques that take into account sex and age, as well as the South African population. The aim of this study was to provide an automated computer-assisted method to create accurate statistical models for predicting nasal soft-tissue shape from information about the underlying skull substrate using CBCT scans.

The database contains 200 cone beam computer tomography scans (CBCT), belonging to 100 black South Africans and 100 white South Africans, they were selected from the Oral and Dental Hospital, University of Pretoria, and the Life Groenkloof Hospital, Pretoria, South Africa. The acquisition and extraction of the 3D relevant anatomical structures (hard- and soft-tissue) were performed by an automated three-dimensional (3D) method based on an automatic dense landmarking procedure using MeVisLab © v. 2.7.1 software. An evaluation of shape differences attributed to known factors (ancestry, sex, size and age) was performed using geometric morphometrics, while statistical models of prediction were created using a Projection onto Latent Structures Regression (PLSR) algorithm. The accuracy of the estimated soft-tissue nose was evaluated in terms of metric deviations on training and on un-trained datasets. Our findings demonstrated the influence of factors (sex, ageing and allometry) on the variability of the hard- and soft-tissue among two South African population groups.

This research provides accurate statistical models optimised by including additional information such as ancestry, sex and age. When using the landmark-to-landmark distances, the prediction errors ranged between 1.769 mm and 2.164 mm for black South Africans at the tip of the nose and the alae, while ranging from 2.068 mm to 2.175 mm for the white subsample. The prediction errors on un-trained data were slightly larger, ranging between 2.139 mm and 2.833 mm for the black South African sample at the tip of the nose and the alae and ranging from 2.575 mm to 2.859 mm for the white South African sample.

This research demonstrates the utilisation of an automated three-dimensional (3D) method as a convenient prerequisite for providing valid and reliable nose prediction models independent of any forensic artistic interpretations.

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