Evolution of cephalometrics based on Professor Delaire's architectural and structural analysis

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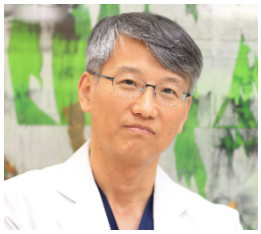

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The cephalometric analysis has long been an essential tool in the treatment of craniofacial dysmorphosis as well as for the growth evaluation. The architectural and structural craniofacial analysis of Professor Delaire has attained a unique status due to its evaluation of the mutual balance between the face and cranium on an individual basis. Recent advances in medical imaging and information technology have led to the transition from original two-dimensional (2D) cephalometrics through three-dimensional (3D) analysis to automatic 3D cephalometrics. We already set up a systematic sequence for 3D cephalometry and surgical planning and provided the norm data. We also validated the 3D data through comparison with 2D data for Koreans and fully applied this system to all clinical cases.

Recently various machine learning methods have yielded remarkable results for 3D automatic cephalometrics, especially for the lengthy time and inconvenience of manual approaches. We developed some machine learning-based automatic systems; the first was an automatic system based on multi-stage deep reinforcement learning and volume-rendered imaging. It considered human professional landmarking patterns and characteristics of landmarks. Another method employed a shadowed 2D image-based machine learning to capture 3D geometric cues, followed by a rough estimation by utilizing the low dimensional representation learned by variational autoencoder, and final coarse-to-fine detection.

Considering evidenced discrepancies between 2D, 3D, and 3D automatic system, 3D Delaire's analysis needs to be conducted based on original philosophy, norms, and a sound 3D and deep-learning basis for the sake of its accurate application and widespread adoption.