Use of 3D photogrammetry in the craniofacial assessment of Noonan syndrome.

Peter Hammond[1], Tim J Hutton[1], Michael A Patton[2], Judith E Allanson[3]

[1]Biomedical Informatics, Eastman Dental Institute for Oral Health Care Sciences, University College London, UK, [2]Clinical Genetics, St George's Hospital Medical School, London, UK, [3]Eastern Ontario Regional Genetics Program, Ottawa, Canada.

Objective evaluation of the face, through the use of anthropometry, cephalometry or photogrammetry, has been used to supplement syndrome identification for many years. Anthropometry can enhance subjective or gestalt impressions of facial appearance, by focussing the eye of the observer on facial dimensions which are most discrepant from normal, and which best distinguish the syndrome. For over 45 years, 2D photographs have been used as a quickly obtained, permanent record of a patient's appearance. Measurements can be taken directly from photographs, however errors occur due to pose and lighting, palpation of hard tissue landmarks is not possible, and standardisation is difficult.

We have studied the faces of 22 individuals with Noonan syndrome using a standard anthropometric approach. Measurements were carried out by one of the authors (JEA). On the same day, a TCTi DSP 400 scanner recorded 3D images of both facial geometry and appearance. An additional 28 children of similar age, from the general population, have also been scanned. The scanner uses six cameras, two to generate slightly off centre right and left portraits, and four to provide separate stereo video views that are composed into a single surface, and onto which the two portraits are projected to generate facial appearance. The surface geometry, typically involving between 4,000 and 9,000 vertices, and appearance can be viewed separately or in combination. Simultaneous capture of surface geometry and appearance aids visualisation and subsequent landmarking. Image manipulation and data visualisation are provided by *ShapeFind* software developed by two of the authors (TJH, PH).

This study has demonstrated the advantages of 3D photogrammetry over 2D photography. Problems with pose are avoided and landmarking is facilitated by being able to view the face from any desired angle. The majority of computer-derived measurements agree well with the manual craniofacial assessment. Some discrepancies are accounted for by problems in image capture. The 3D facial images of control children and children with Noonan syndrome have undergone preliminary analysis, providing good delineation of the features of Noonan syndrome and excellent 3D visualisation of facial shape variation. The use of principle component analysis to generate major modes of 3D facial shape and appearance variation in syndromic faces is novel. Composite variation of multiple modes offers an impressive and powerful tool to show continuous transition between the syndromic and non-syndromic face. 3D photogrammetry and the visualisation tools provided in *ShapeFind* both discriminate between normal and syndromic face and train the eye in a 3D gestalt mode.