Int. J. Oral Maxillofac. Surg. 2012; 41: 783–788
doi:10.1016/j.ijom.2012.02.003, available online at http://www.sciencedirect.com

International Journal of Oral & Maxillofacial Surgery

Clinical Paper
Cleft Lip and Palate

Facial dimensions of Malay children with repaired unilateral cleft lip and palate: a three dimensional analysis

M. Zreaqat[1], R. Hassan[1], A. S. Halim[2]
[1]Orthodontic Unit, School of Dental Science, Universiti Sains Malaysia, Malaysia;
[2]Reconstructive Sciences Unit, School of Medical Science, Universiti Sains Malaysia, Kelantan, Malaysia

M. Zreaqat, R. Hassan, A. S. Halim: Facial dimensions of Malay children with repaired unilateral cleft lip and palate: a three dimensional analysis. Int. J. Oral Maxillofac. Surg. 2012; 41: 783–788.

Abstract. This comparative cross-sectional study assessed the facial surface dimensions of a group of Malay children with unilateral cleft lip and palate (UCLP) and compared them with a control group. 30 Malay children with UCLP aged 8–10 years and 30 unaffected age-matched children were voluntarily recruited from the Orthodontic Specialist Clinic in Hospital Universiti Sains Malaysia (HUSM). For the cleft group, lip and palate were repaired and assessment was performed prior to alveolar bone grafting and orthodontic treatment. The investigation was carried out using 3D digital stereophotogrammetry. 23 variables and two ratios were compared three-dimensionally between both groups. Statistically significant dimensional differences ($P < 0.05$) were found between the UCLP Malay group and the control group mainly in the nasolabial region. These include increased alar base and alar base root width, shorter upper lip length, and increased nose base/mouth width ratio in the UCLP group. There were significant differences between the facial surface morphology of UCLP Malay children and control subjects. Particular surgical procedures performed during primary surgeries may contribute to these differences and negatively affect the surgical outcome.

Key words: unilateral cleft lip and palate; facial morphology; surgical outcome; stereophotogrammetry.

Accepted for publication 2 February 2012
Available online 15 March 2012

The objective of all cleft surgery is to minimize the visible stigmata of the cleft-related deformity to create a symmetric, aesthetic, and functional nasolabial region. Health-related quality-of-life outcome measures can be viewed as a supplement to the more objective clinical indicators in assessment of the severity of facial deformity and the impact of surgical treatment. Assessment of the appearance of the cleft-related deformity is thus an important component of the quality of treatment outcome for patients with cleft lip and palate. Precise measures that capture comprehensively the effects of treatment for cleft lip and palate must be available. Without these, accurate comparison among surgical treatment procedures cannot be made.

Various methods have been used to assess the cleft-related deformity qualitatively and quantitatively. Several studies used anthropometry, which could provide a mean of quantitative analysis of the extent of abnormal morphology and the degree of disproportion associated with the repaired cleft lip and palate. Farkas et al.[1] established many anthropometric measurements of the cleft lip and nasal complex through direct linear and proportional measurements. These data were compared with similar assessments made in normal children of similar age. Friede

0901-5027/060783 + 06 $36.00/0

et al.[2] measured angular, linear, and surface dimensions using a plaster cast of the midface of patients with unilateral cleft lip and palate (UCLP). These data were used to evaluate the results of different surgical techniques.

An objective assessment of facial morphology and asymmetry associated with cleft lip and palate has also been undertaken by assessing photographs including frontal and lateral facial views[3], others used views cropped below the eye.[4] Asher-McDade et al.[5] developed a standardized method to assess the facial appearance of patients with unilateral cleft lip and palate. Standard frontal and lateral photographs related to the nasoalbial area were rated using a 5-point ordinal scale.

These methods project a complex three-dimensional (3D) structure onto a two-dimensional plane, causing loss of one of the facial dimensions, usually facial depth. These methods are also overshadowed by measurement errors due to subjective analysis, magnification, parallax, variation in lighting, head orientation, and distance between the subject and the camera.[6] Correct evaluation of the surface of the face should involve all three spatial planes.[7] Recent advances in technology have made 3D imaging and analysis possible.[8] These include laser scanning, computed tomography (CT), 3D morphoanalysis, and stereophotogrammetry. CT is not an ideal technique for surface measurements because of poor resolution of facial contours, exposure to ionizing radiation, and the need for general anaesthesia in young subjects. Laser surface scanning is reliable and accurate for identifying craniofacial surface landmarks, but image capture can be slow (up to 20 s) and result in motion artefact. This is because it is often difficult for patients, especially children and developmentally disabled subjects, to maintain posture for this period of time.[9]

Stereophotogrammetry is based on the principle of photographing a 3D object from two pairs of identical cameras separated by a known base distance. The result is a stereo pair of photographs of the face taken from two different positions at the same instant. The basis of all methods of measurement is the fusion of the two photo images to form a 3D model.

The advantages of 3D stereophotogrammetry are near-instantaneous image capture (of the order of 1.5 ms) which minimizes motion artefact, provision of archived images for subsequent and repeated analyses, collection of data points in 3D coordinate format for subsequent morphometric studies, and high resolution colour representation. Software tools that allow the user to manipulate images to facilitate identification of landmarks and calculate anthropometric measurements are available.[10]

In Malay subjects with cleft lip and palate, dental arch relationships,[11] speech and hearing development,[12] and psychological status[13] have been assessed, while evaluation of facial morphology has received no attention. The aim of this study was to assess objectively facial surface dimensions of a group of Malay children with UCLP and compare them with a control group. Results of this study should provide the region with a level of information that is presently unavailable.

Materials and methods

This study was approved by the institutional Research and Ethics Committee. 30 consecutive patients (14 males and 16 females, mean age 9.4 years) were recruited from the Orthodontic Specialist Clinic of the institution during interdisciplinary consultations with cleft lip and palate children and their parents between 2006 and 2009. All participants were presented with non-syndromic complete left-sided unilateral cleft lip and palate. All cleft surgery was undertaken by two nominated plastic surgeons following the same protocol; the lip was closed at 3 months of age using a modified Millard rotation advancement, and the palate was closed at 9–12 months using a two-flap pushback palatoplasty. Particular attention was paid to muscle dissection and subsequent muscle union. Neither presurgical orthopaedics nor bone grafting was performed. Patients had received their dental care from the team of oral surgeons, paediatric dentists, restorative dentists, and orthodontists. Speech pathologists had participated in the multidisciplinary team through parents' interviews, provision of information, and regular reviews. The control group comprised 30 unaffected age-matched volunteer Malay children (also 14 males and 16 females with a ratio of 1 m:1 f in both groups) recruited from orthodontic clinics at the same institution excluding any child in whom skeletal disproportion was a feature of the malocclusion. Children who received or were under active orthodontic treatment were also excluded. Careful matching for the subjects' weight and height was applied.

Only children who had similar weight and height (differences were less than 1.5 kg in weight and 2 cm in height), among both groups were included in the study. Dentoalveolar relationships were assessed and matched between groups; the control group comprised children with mild Class II, Class I, and mild Class III dental arch relationships and those were matched with UCLP patients categorized as measuring grades one, two, and three on the Goslon Yardstick.[11]

This study used a 3D digital stereophotogrammetry acquisition unit. The 3D stereophotograms were captured using the DSP-400 system (3dMD LLC, Atlanta, GA, USA). The DSP-400 system has four camera pods, each consisting of two geometry cameras, one texture camera, one white light flash, and one speckle flash. The centre pod has an additional ambient light in the base. Subjects were positioned 92 cm from the front of the middle pod, as upright as possible and with all areas that need to be captured visible in the screen view. The patients were seated in the natural head position with the mandible in the rest position and the lips lightly opposed if this was possible without undue muscular effort. The capture time was 2 ms with standard fluorescent lighting at normal light levels. The rapid imaging allows the evaluation of alert and uncooperative children. Thus, the technique overcomes several limitations of direct anthropometry. The processing time to convert the captured image to a viewable 3D image was 2–3 min. System calibration following the manufacturer's protocol was performed before every imaging session according to the manufacturer's instructions.

Anthropometric landmarks related to the eyes, nose, ear, lips, and chin were identified on each image for both groups (Fig. 1). 29 3D facial measurements related to these landmarks were recorded (in mm) using 3dMDvultus software (3dMD, Atlanta, GA, USA). In addition, two ratios (lower facial height/total facial height (LFH/TFH) ratio and alar base width/mouth width ratio (al-al/ch-ch) and one angular measurement (gonial angle) were recorded. Gonial angle was determined as the angle formed between the ramus line (Pre-Go) and the mandibular body line (Go-Gn) and was calculated as an absolute quantity. Many of the soft-tissue landmarks used in this study were proposed by Farkas et al.[1], but a novel aspect in the current study was the establishment of 3D assessment of certain facial dimensions (zygomatic arch length, ramus length, distance between ear and nose, and gonial angle) (Table 1). Work activities within the software allowed high-quality polygon meshes, accurate freeform surfaces, and geometrically perfect solid models to be created and analysed