American Association of Orthodontists FOUNDATION Research Awards to CWRU Department of Orthodontics

1995 Award:

Randomized Clinical Trial of a Dental Device for Treatment of Snoring and/or Obstructive Sleep Apnea Syndrome

(1)

Mark G. Hans, (PI), Suchitra Nelson, Virginia G. Lucks, Paul Lorkovich and Seung-Jin Baek

Title: *Comparison of two dental devices for treatment of obstructive sleep apnea syndrome(OSAS)*

Case Western Reserve University School of Dentistry, Cleveland, OH

Abstract:

Previous case reports have indicated dental devices can be an effective nonsurgical treatment for snoring and obstructive sleep apnea. This pilot study evaluated the effectiveness of two intraoral devices in reducing the Respiratory Disturbance Index (RDI) and Epworth Sleepiness Scale (ESS) scores in a group of 24 adult volunteers with a history of loud snoring. Subjects were randomly assigned to two groups. Twelve subjects were fitted with a dental device designed to increase vertical dimension and protrude the mandible (device A). The other 12 subjects received a different device designed to minimally increase vertical opening without protruding the mandible (device B). Unattended home sleep monitoring (Edentrace II Digital Recorder, Edentech Corp.) was used to compute RDI at two time periods: (T0) before using any dental device and (T1) while using a dental device 2 weeks after the initial delivery date. The mean RDI and ESS scores at T0 for subjects in the device A group were 35.6 ± 28.4 and 12.0 ± 3.9, respectively. Means for the same measures at T1 were 21.1 ± 21.4 and 8.2 ± 4.0. For subjects in the device B group, means for RDI and ESS scores at T0 were 36.5 ± 43.7 and 13.0 ± 4.5, the means at T1 were 46.8 ± 47.0 and 12.5 ± 5.7. The effectiveness of the two devices was estimated by comparing the difference in RDI scores from T0 to T1 for the 10 subjects who were using device A and completed the study and the 8 subjects who were using device B and completed the study. Six subjects withdrew for various reasons. From T0 to T1, device A reduced RDI scores in 9 of 10 subjects, with a mean reduction in RDI of 14.5 ($p \leq 0.05$) and in ESS score of 3.8 ($p \leq 0.005$). Device B showed no change or an increased RDI score in 8 of 8 subjects. Seven of the eight subjects who showed no improvement in RDI with Device B were then fitted with device A. Four of these seven subjects showed a reduction in RDI and five showed a reduction in ESS after using device A for 2 weeks. The mean reduction in RDI and ESS was 2.4 ± 19.8 and 2.4 ± 3.0, respectively. Hence, we conclude that a dental device that advances the mandible and increases the vertical dimension to open the upper airway is more effective in reducing the number of apneic and snoring events during sleep than one which does not. (Am J Orthod Dentofac Orthop 1997;111:562-70.)

1997 Award:

Genetic Dissection of Craniofacial Morphologic Traits

(1)

SJ Park, (PI), MG Hans, AJ Thomas, A Moullas, S Iyengar, BD Amberman, and KP Strohl

Title: *Rat Craniofacial Morphologic Traits in F1 Offspring*

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Abstract:

Phenotypic strain variations in craniofacial dimensions have been previously demonstrated for Brown-Norway (BN) and Sprague-Dawley (SD) rats. The present study examined the distribution of 20 dry skull measurements in the F1 offspring obtained from a SD male and BN female cross. Means and standard deviations for the 20 measurements were computed for a sample of 23 four-month old F1 hybrid rats (11 male, 12 female) and compared with the measurements from the F0 parents, an age-matched group and same gender inbred groups (n-18). It was found that measurements could be grouped into three types. The first were measurements that show large strain variation and gender difference. For this type of measurement, the mean values for the F1 generation were between the values measured for the parents. Most of the length measurements in the craniofacial complex were in this category. The second type of measurements had less strain variation and larger gender differences. The measurement values of the F1 animals were smaller than those of the parents but larger than those of age matched groups. The width and height measurements commonly belonged to this category. The third type of measurement showed little difference between the F1 generation and the parental rats. There was little variation for strain difference or sexual dimorphism for this type of measurement. Tooth measurements were included in this group. These findings suggested various inheritance patterns for craniofacial morphometric traits in rats. Future studies of F2 progeny are planned to further evaluate mechanisms of inheritance and identify possible candidate genes.

(2)

AT Moullas (PI), CV Couto, JM Palomo, G Chan, MG. Hans, AJ Thomas, and KP Strohl

Title: *Variations in craniofacial shape for two lineages of rats*

Case Western Reserve University School of Dentistry, Cleveland, OH

While several studies have examined the developmental aspects of craniofacial components, no studies have evaluated the relative contribution of genetics and gender to the formation of the adult craniofacial phenotype. The purpose of this study was to determine if the difference between rat strains is greater than inter-genders variation within each lineage. Fully mature adult rats (4 males and 4 females) were used. Sprague-Dawley (SD) and Brown-Norway (BN) were selected. Lateral head films were taken, and 12 anatomical landmarks representing cranial base, maxilla, mandible and nsal bone (length, width and height) were identified. Using the CRILL software, x and y coordinates of these landmarks were identified. The sample was then divided into four group, SD male (SDM) and female (SDF), and BN male (BNM) and female (BNF). Using SPLUS (Mathsoft, Ind.) we did a procrustes superimposition for an inter-gender and inter-strain shape comparison. The total variation was calculated in Procrustes Distance Units (PDU). The greatest variation was found when comparing the males

between strains (94.2 PDU), followed by the females between strains (88.6 PDU), the inter-gender comparison for the SD (73.6 PDU), and the inter-gender comparison for BN (27.5 PDU). Based in our sample we conclude that there is considerably greater variation when comparing different strains, and that the inter-gender shape variation for the Brown Norway rats was considerably smaller than for the Sprague-Dawley.

1998 Award:

Three Dimensional Cephalometric Outcome Assessment of Orthognathic Surgical Procedures

(1)

M Valiathan (PI), MG Hans, S Nelson, M Powers and JM Palomo

Comparing Operator and computer Generated Cephalometric Based Orthodontic Problem Lists

Case Western Reserve University, Cleveland, OH

Abstract

Cephalometric software packages are being used more often in clinical orthodontics. The present study enrolled 15 orthognathic surgery patients and compared skeletal problem lists generated by two commercially available cephalometric software packages (A and B) to a panel of 10 experienced orthodontists. Lateral and postero-anterior cephalograms were taken one week before surgery. Based on the orthodontist's opinion or, for the computer programs, on the number of standard deviations from the norm, maxillary anterior-posterior (AP) position [MXAP], mandibular AP position [MDAP], lower anterior facial height [LAFH] and asymmetry [ASYM] were categorized using a 7 point ordinal scale. Simple frequency distributions were calculated for each trait for each patient, and the percent agreement with the mode was calculated for each clinician and both computer programs. Program A demonstrated greater agreement with the mode of the clinician group than Program B for two measures (ASYM 73.7% vs. 53.6% and MDAP 46.9% vs. 13.4%). However, Program B fared better than Program A in the remaining two assessments (MXAP 26.8% vs. 33.5% and LAFH 46.9% vs. 33.5%). When each clinician was compared to the clinician group mode, agreement ranged for MXAP from 33.3% to 86.7%, for MDAP from 46.7% to 80.0%, for LAFH from 40.0% to 73.3% and for ASYM from 53.3% to 80.0%. The results indicate considerable range in agreement amongst experienced orthodontists in the evaluation of these skeletal traits. However, in all cases clinicians exhibited greater consistency than that observed for the software programs. The results suggest that problem lists generated by cephalometric software packages are less consistent than lists generated by the 10 clinicians.

(2)

Hans, MG (PI), Palomo, JM, Dean, D, Cakirer, B, Min, K-J, Han, S and Broadbent, BH.

Three-Dimensional Imaging: The Case Western Reserve University Method

Case Western Reserve University, Cleveland, OH

Abstract

The goal of this project was to create a lifelike digital record of human dentofacial morphology. Traditionally, orthodontists have relied on a lateral and sometimes a frontal cephalometric radiograph, three facial and three intraoral photographs, and upper and

lower dental study casts to capture the dentofacial morphology of their patients. Creating a unified digital record of dentofacial morphology requires all records to share the same space. Therefore, to be lifelike, all records should eventually be positioned within a computer (on-screen) representation of the three-dimensional (3D) space of the patient's head. This requirement necessitated that radiographic and facial surface morphology be rendered in 3D and that 3D study casts be converted to digital format. This article describes the Case Western Reserve University method for (1) rendering the lateral and frontal biorthogonal cephalogram pairs in 3D; (2) capturing the 3D surface of the human face; (3) converting the plaster dental cast data to a 3D digital record: and (4) integrating lateral and frontal radiographs, facial surface scans, and digital study models into a single 3D patient record. In addition, the creation of standard 3D cephalometric wireframes using the Bolton Standard subjects is described. Finally, two case reports are presented to show the use of this 3D digital record to analyze craniofacial hard and soft tissue changes brought about by Le Fort I maxillary advancement surgery. In the case reports, traditional cephalometric superimpositions are compared with 3D color-coded surface superimpositions of the preoperative and postoperative facial images. The advantages and disadvantages of this digital outcomes assessment method are discussed in this presentation of a model for the future 3D orthodontic patient record.

(3)
B. Cakirer (PI), D. Dean, J. Goldberg, and MG Hans
A New Method for 3D Orthognathic Surgical Shape Analysis.
Case Western Reserve University
Abstract
Traditionally, cephalometric analysis of 2D landmarks has been limited to distances, indices, and angles. Quantitative results vary depending on what baseline is chosen. Geometric Morphometric techniques, such as Procrustes superimposition, assume all landmarks carry equivalent information. Using these methods, landmark coordinates (x, y, z) facilitate patient and 'normative' shape comparison and pre to post-surgical outcome assessment. Pre and post-surgical lateral and frontal cephalograms and stereophotograms (Visual Interface Inc., Pitts., PA) were taken of a 48-year-old white male. Traditional cephalometric analysis showed facial asymmetry and maxillary deficiency. Coordinates of 17 3D hard-tissue landmarks were collected directly from scanned cephalograms with out 3dCEPH software and 29 3D soft-tissue landmarks were collected on-screen using VI Studio (Visual Interface Inc.). Reproducibility of less than 2 mm was measured by repeating landmark localization 5 times. Procrustes superimposition between pre-surgical and normative 3D 18 -year-old male Bolton Standard data confirmed the traditional cephalometric diagnosis. After the maxillary advancement 13.9% of overall skeletodental shape change was at A point, 13.5% at posterior nasal spine, and less than 10% at any other landmark. After surgery 48.7% of overall soft-tissue shape change was seen at nose, 25.7% at mouth, and 25.6% at chin landmarks. The overall shape difference between the patient and 3D Bolton standard decreased 1.2% post-surgically. Unlike traditional baseline dependant methods, Procrustes shape analysis produces a single useful measure of surgical shape change or comparison to normative shape.

(4)

D Dean, PI) B H Broadbent, Jr, M Valiathan, M Hans, E Luce, J Goldberg

3D Soft Tissue Face Bolton Standards

Case Western Reserve University, Cleveland, OH

Abstract

The Bolton-Brush Growth Study (BBGS), conducted at Case Western Reserve University from 1927-1959, resulted in 22,000 biorthogonally registered plain film head x-ray pairs. These frontal and lateral "cephalograms" were captured annually from 4309 participants, aged 3-18. Three dimensional (3D) soft tissue, boney, and dental landmark coordinate data has been captured from the x-ray series of 32 (16 male and 16 female) BBGS participants, a clinically well known "normative" cohort, the "Bolton Standards." During recall visits of the Bolton Standards participants to the BBGS Center we are collecting 3D CT-scans and new biorthogonal head x-ray pairs. The soft tissue face surface image is extracted from each 3D CT-scan and a deformable template is superimposed. This template includes crest lines, referred to as "ridge curves" (e.g., around the eyelids, lips and ears). Landmarks found recurrently at points of maximum curvature along these ridge curves are identified. These curvature maxima landmarks are used as the endpoints for geodesic lines which tile out the surface into homologous patches. Next, as a calibration step, the current 3D CT-extracted soft tissue face image is superimposed onto a subset of the curvature maxima landmarks located on the biorthogonal plain film x-ray pair. Finally, the 3D CY soft tissue face image is warped, via a thin plate spline, to the same 3D landmarks seen in the biorthogonal film pairs taken during the Bolton Standards' sub-adult visits. The deformable template is also used to superimpose and average the Bolton Standards soft tissue face images across each age group to produce new "normative" images of growing children. The resulting longitudinal series of average "normative" soft tissue face images may now be used for patient diagnosis, treatment planning, stereotactic procedures, and outcomes assessment.