The Joint Cephalometric Experts Group (JCEG) Project
A link with the past-A promise for the future.
November 13-15 2010 Cleveland, Ohio

Executive Summary

Background: To map the transition from 2D cephalometrics to 3D cone beam imaging for assessment of orthodontic outcomes as well as diagnosis and treatment planning. Significance: In 2001, the introduction of low cost, low radiation dose, high resolution cone beam computed tomography in clinical orthodontics created the potential for new discoveries in craniofacial biology and facial growth. This technology provides researchers and clinicians with the tools needed to study 3D changes in craniofacial anatomy associated with the growth process and clinical care. In the 20th century, radiographic cephalometry was a pioneering advance that led to many fundamental insights into the effects of orthodontic treatment. CBCT imaging promises similar advances in the 21st century.

Recommendations by focus group:

Superimposition – There was consensus on the importance of overall and regional superimposition of longitudinal images. Equal importance was given to superimposition using landmarks and voxel data based on anatomic region. The relevance of existing 2D superimposition methods was affirmed as was the need to educate residents in classic cephalometric analysis.

Registration- Software that allows the operator to assign the point with coordinates (0,0,0) is desirable. Operator assisted natural head position should be used for image acquisition. No consensus on planes of reference could be reached.

Nomenclature/Terminology- With this area was recognized as important for the specialty, the consensus was that this area could best be handled by existing groups with organized dentistry and will not be included in JCEG III for discussion.

3D Morphologic Standards- The consensus was to use the existing 2D Bolton landmarks and drawing and extend both the landmarks and graphics to 3D. The importance of acquiring normative 3D datasets was also noted although consensus could not be reached on the best method for acquiring them.

Image Quality and Machine Parameters –It was recommended that CBCT manufacturers be required to report both the voxel size and the line pair resolution of their products. The largest volume should include all facial and cranial structures.

Database of 3D CT images –DICOM standards should be used for image databases and the following stratification variable should be encoded in the image dataset. Gender, Age, Angle Class, Ethnicity (self reported), Extraction of teeth.

There was overwhelming interest in meeting again next year to discuss these issues and to begin discussion of 3D casts.

Registered Attendees:

Alarbi Mark	Jacksonville University
Barry Mark	ESM Digital Solutions
Baumrind Sheldon	University of the Pacific
Beeson Dennis	Case Western Reserve University
Behrents Rolf	St. Louis University
Carmen Jesse	Case
Cevidanes Lucia	UNC
Chitharanjan Aparna	CWRU
Cho Heon Jae	University of the Pacific
Choi Jack	Anatomage
Conley Scott	University of Michigan
Dibbets Jos	Gronigan University
Dolce Calogero	University of Florida
EL HAKAN	Istanbul, Turkey
Evangelinakis Nikolaos	CWRU
Evans Carla	University of Illinois
Gladstone Ken	Dolphin Imaging
Gulyani Seema	UIC(MS student)
Hans Mark	
Harrell William	AAO
Johnston Lysle	University of Michigan
Karamitsou Eleftheria	CWRU
KAU CHUNG HOW	UT Houston
Kim Andrew	INFINITT North America, Inc
Kim Eunjeong	Kyung Yi Univ Korea
KUSNOTO BUDI	U OF ILLINOIS AT CHICAGO
Larson Brent	University of Minnesota
Leite Luis	Medical University of South Carolina
Maganzini Anthony	Montefiore Medical Center/Albert Einstein College of Medicine
Magni Toni	TOPS Ortho
Magni Franco I	talian Society of Orthodontists
McNamara James	University of Michigan
Miyamoto Michael	CWRU Ortho Student
Miyashita Kunihiko	Tokyo, Japan
Molen Aaron	UCLA Section of Orthodontics
Nguyen Tung	UNC Dept of Orthodontics
Palomo Martin	Case Western Reserve University
Pan Yunqing	University of Illinois at Chicago
Park Robert	CWRU Ortho Student
Paulus Brent	CWRU Ortho Student
Sabat Michael	Orthodontist, Parma Ohio
Schilling Lindsey	Case Western Reserve University
Scholz Robert	Ortho2
Singer Richard	Nova Southeastern University

Spoon Michael	Eastman Dental Center
Spoon Michael	Eastman Dental Center
Sullivan David	CWRU Ortho Student
Valiathan Manish	CWRU
Wang Chester	Dolphin Imaging
Wheeler Timothy	University of Florida
Wu grace	CWRU Ortho Student
Zarka randa	CWRU Ortho Student
Zhang John	Peking University China

Introduction

On November 21, 2008, the Joint Cephalometric Experts Group met in Cleveland at the historic Bolton Brush Growth Study Center for two days to discuss the state of the art in 3D CBCT imaging. In attendance were international leaders in imaging and orthodontics. The meeting resulted the formation of the following working groups:

- **Superimposition** --Identify biologically stable and relevant features for superimposition of 3D volumes.
- **Registration**- Establish a set fiducial landmarks within the volume to insure the integrity of the image and to allow landmark data derived from the image to be stored in a known coordinate system.
- **Nomenclature/Terminology**- Develop a lexicon of terms to describe treatment procedures and coordinate them with the ADA SNOWDENT project. Define relevant terms that can be used by JCEG to describe 3D volume data and orthodontic procedures.
- **3D Morphologic Standards**- Combine the existing 3D Bolton Landmark data with surface data acquired from CBCT to create 3D graphical standards that can be used for orthodontic diagnosis and treatment planning-.
- **Image Quality and Machine Parameters** -Propose guidelines for hardware, software and the resulting digital images that can be implemented by the ADA Standards Committee 11.6.
- **Database of 3D CT images** - Develop and implement a database of 3D images for craniofacial research.

Process:

The second meeting of JCEG was held at the Bolton Brush Growth Study Center, Case Western Reserve University, in Cleveland, Ohio from November 13 to November 15, 2009. All members of the orthodontic community interested in CBCT imaging were invited to attend. The meeting was organized around the six working groups estabiished during JCEG I. Each working group,headed by a team of JCEG members, created a prototype prior to the start of the meeting. These "straw men" generated discussion and helped attendees build consensus on some topics in each of these six areas. Three meeting hours were allotted to each of the six topics over the three day period for a total of 18 hours. Each began with a one hour presentation by the working group leaders. This was followed by a one hour discussion in smaller break-out groups of between 7-12 people. Each session concluded with a one hour meeting of the entire group. At the end of each discussion topic the whole group was polled using electronic system that tallied response totals. The response totals for each questions are listed in the following results section.

Results

Topic 1   **Superimpositions- Lysle Johnston/Martin Palomo**
Consensus Questions:

1.   Should superimpositions continue to play a role in orthodontic outcome assessments?
   a. Yes =28
   b. No =2
   c. Don't Know =1
   d. Does Not Matter =0

2.   Do we still need regional superimpositions?
   a. Yes =31
   b. No =1
   c. Don't Know =0
   d. Does Not Matter =0

3.   Should we use data from Bjork's implant studies?
   a. Yes =28
   b. No =4
   c. Don't Know =4
   d. Does Not Matter =1

4.   Should landmarks still be part of the equation, when dealing with 3D superimposition?
   a. Yes =25
   b. No =4
   c. Don't Know =7
   d. Does Not Matter =2

5.   Should areas or regions be part of the superimposition process?
   a. Yes =31
   b. No =1
   c. Don't Know =4
   d. Does Not Matter =0

6.   Should objective data be expected out of a superimposition?
   a. Yes =28
   b. No =2
   c. Don't Know =5
   d. Does Not Matter =0

7.   Should we continue to train residents to do 2D cephalometrics?
   a. Yes =31
   b. No =4
   c. Don't Know =0
   d. Does Not Matter =0

8. Should we continue to train residents to do 2D superimpositions?
    a. Yes =34
    b. No =1
    c. Don't Know =1
    d. Does Not Matter =0

9. Would side to side oriented volumes, be as useful as a
    superimposition?
    a. Yes =9
    b. No =13
    c. Don't Know =5
    d. Does Not Matter =0

10. Should the superimposition be viewed in 3D "surface" mode?
    a. Yes =25
    b. No =6
    c. Don't Know =5
    d. Does Not Matter =0

11. Should commercially available software offer consistent methods
    for superimposition?
    a. Yes =27
    b. No =5
    c. Don't Know =1
    d. Does Not Matter =1

12. Is it possible to agree on a superimposition method as a specialty?
    a. Yes =9
    b. No =24
    c. Don't Know =4
    d. Does Not Matter =0

13. What is your preference for superimposition?
    a. Landmark -10
    b. Voxel- 12
    c. Surface- 5
    d. Slices-3
    e. Don't Know-1

Topic 2   **Registration-Behrents/Baumrind**

Consensus Questions:

1. Is it important to be able to find and/or assign the 0.0.0 point in the volume?
   a. Yes-20
   b. No-8
   c. Don't Know-2
   d. Does not matter-0
2. Should Frankfort plane be the primary Horizontal reference?
   a. Yes-15
   b. No-14
   c. Don't Know-2
   d. Does not matter-0
3. Should the frontal bizygomatic frontal suture be our primary coronal reference plane?
   a. Yes-9
   b. No-15
   c. Don't Know-7
   d. Does not matter-0
4. Should we accept midline nasion as the primary sagital reference?
   a. Yes-20
   b. No-8
   c. Don't know-3
   d. Does not matter-0
5. Is it important to standardize head position?
   a. Yes-28
   b. No-3
   c. Don't Know-1
   d. Does not matter-0
6. Should we use operator assisted natural head position?
   a. Yes-19
   b. No-8
   c. Don't Know-2
   d. Does not matter-2

Topic 3   3D Morphologic Standards- Larson, Miyashita and Harrel
Consensus Questions:

1. Should we implement the Bolton Morns in 3D?
   a. Yes = 20
   b. No = 3
   c. Don't know = 4

2. How should we fill the data gaps found in 2D norms?
   a. Ideal individual = 4
   b. Mean info from selected subjects = 20
   c. No need = 2
   d. Don't know = 1

3. Are norms important?
   a. Yes = 21
   b. No = 7
   c. Don't know = 1
   d. It doesn't matter = 0

4. Should we use existing 3D normative datasets?
   a. Yes = 22
   b. No = 4
   c. Don't know = 1
   d. It doesn't matter = 1

5. Should there be norms for different ethnical backgrounds?
   a. Yes = 24
   b. No = 3
   c. Don't know = 0

6. Can we use data from an ideal subject as basis for norms?
   a. Yes = 12
   b. No = 13
   c. Don't know = 2

7. What would be the preferred way for 3D norm display?
   a. Graphical = 20
   b. Numerical = 7
   c. Don't know = 0

8. Is the use of existing landmarks adequate in 3D?
   a. Yes = 9
   b. No = 15
   c. Don't know = 15

9. Should JCEG develop a new glossary of terms?
   a. Yes = 7
   b. No = 11
   c. Don't know = 0

10. Should JCEG define 3D landmarks?
    a. Yes = 22
    b. No = 3
    c. Don't know = 1

11. Should we create a ceph, from CBCT and use traditional cephalometrics at this point?
    a. Yes = 15
    b. No = 9
    c. Don't know = 2

12. Are longitudinal data important for creation of norms?
    a. Yes = 23
    b. No = 6
    c. Don't know = 0

13. Should we try to use soft tissue scans to develop norms?
    a. Yes = 18
    b. No = 12
    c. Don't know = 1

14. What should we use to collect new longitudinal data?
    a. MRI = 6
    b. Soft Tissue = 2
    c. CBCT = 13
    d. No need = 2
    e. Don't know = 2

| Topic 4 | **Image Quality and Machine Parameters hardware phantoms -Palomo and Caruso** |
| Topic 5 | **Magni Image Standards** |

Consensus Questions:

1. Should we require line pair resolution data as an important measure of image quality?
   a. Yes=25
   b. No=2
   c. Don't Know=4

2. Should each isolated image contain 8 Baumrind fiducial markers?
   a. Yes = 11
   b. No = 15
   c. Don't know = 1
   d. It doesn't matter = 0

3. Should we have calibration points?
   a. Yes = 25
   b. No = 3
   c. Don't know = 0
   d. It doesn't matter = 0

4. For a CBCT scan with incomplete spatial information (voxel size, scanner used,...) is restoration of that data important?
   a. Yes = 12
   b. No = 10
   c. Don't know = 6
   d. It doesn't matter = 0

5. Do you think we can collect enough information from a CBCT that could replace casts?
   a. Yes = 11
   b. No = 13
   c. Don't know = 2

6. Would a higher radiation dosage be justified if a dental cast could be created from the CBCT?
   a. Yes = 4
   b. No = 23
   c. Don't know = 0

7. What would be the vertical limits for a large Field of View Image?
   a. Glabella-Menton =1

   b. Nasion-Menton   =5
   c. Nasion-Hyoid   =1
   d. Glabella-Hyoid = 20
   e. Don't Know   =4

8. What would be the anterior-posterior limits of the Large FOV?
   a. Nasal Tip-Porion =4
   b. Nasal Tip-Basion =6
   c. Nasal Tip-1" behind porion   =1
   d. Nasal Tip –Opisthium   =18
   e. Don't Know   =2

Topic 6   Database of 3D CT images- Dibbets, Baumrind, McNamara

Consensus Questions on data to include in the database in addition to the images:

1. Gender
    a. Yes = 20
    b. No = 1

2. Age (year/mo)
    a. Yes = 16
    b. No = 2

3. Date of Birth
    a. Yes = 13
    b. No = 6

4. Ethnicity (self reported)
    a. Yes = 17
    b. No = 4

5. Country of Origin
    a. Yes = 12
    b. No = 10

6. Angle Classification
    a. Yes = 17
    b. No = 6

7. Extractions (yes/no)
    a. Yes = 22
    b. No = 0

8. Over-jet (pre-selected options)
    a. Yes = 18
    b. No = 3

9. Overbite (pre-selected options)
    a. Yes = 16
    b. No = 7

10. Teeth together or apart
    a. Yes = 15
    b. No = 2

11. Longitudinal marker
    a. Yes = 8
    b. No = 11

12. Congenital missing teeth
    a. Yes = 7
    b. No = 9

13. Spacing
    a. Yes = 14
    b. No = 10

Summary by focus group:

Superimposition – There was consensus on the importance of overall and regional superimposition of longitudinal images. Equal importance was given to superimposition using landmarks and voxel data based on anatomic region. The relevance of existing 2D superimposition methods was affirmed as was the need to educate residents in classic cephalometric analysis.

Registration- Software that allows the operator to assign the point with coordinates (0,0,0) is desirable. Operator assisted natural head position should be used for image acquisition. No consensus on planes of reference could be reached.

Nomenclature/Terminology- With this area was recognized as important for the specialty, the consensus was that this area could best be handled by existing groups with organized dentistry and will not be included in JCEG III for discussion.

3D Morphologic Standards- The consensus was to use the existing 2D Bolton landmarks and drawing and extend both the landmarks and graphics to 3D. The importance of acquiring normative 3D datasets was also noted although consensus could not be reached on the best method for acquiring them.

Image Quality and Machine Parameters –It was recommended that CBCT manufacturers be required to report both the voxel size and the line pair resolution of their products. The largest volume should include all facial and cranial structures.

Database of 3D CT images –DICOM standards should be used for image databases and the following stratification variable should be encoded in the image dataset. Gender, Age, Angle Class, Ethnicity (self reported), Extraction of teeth.

There was overwhelming interest in meeting again next year to discuss these issues and to begin discussion of 3D casts.