GENETIC CONSIDERATIONS IN ORTHODONTIC TREATMENT PLANNING

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Congenital malformations

“Personalized Medicine”
Slavkin, JADA March 2014
50% unknown / split genetic and genetic/environmental

Clinical Exam

Head shape
Jaw shape
Tooth number, structure, eruption
Radiographic deviations

Frequency of minor anomalies by area of discovery

- 2/3 HEAD AND NECK REGION
- 14% 1 MINOR ANOMALY
- 1% NEWBORN HAVE 3+ MINOR; 90% MAJOR ANOMALY

Minor anomalies: limited social/esthetic or functional significance

- Brachydactaly
- Preauricular skin tag

1) Any cautions to treatment?
Primary Failure of Eruption

2) Any important information to convey?
Oligodontia/Colon Cancer

3) Should I refer?
Oral Surgeon, Craniofacial Team, Pediatrician
Medical Geneticist; OMIM, Genetests
The Benefits of Obtaining the Opinion of a Clinical Geneticist Regarding Orthodontic Patients, Hartsfield 2012

4) Orthodontic Diagnosis / Treatment Plan
Planning, tx timing, expectations

General features
- Short stature
- Aplasia of clavicles
- Late closure of sutures
- Low nasal bridge

Dental
- Supernumerary teeth
- Delayed eruption***

CCD (cleidocranial dysplasia)
Runx2/CBFA1
AD
Variability in expression
Skeletal Dysplasia
Cleidocranial Dysplasia

Marfan Syndrome
skeletal, ocular, cardiovascular

- Tall stature
- Elongated extremities
- Scoliosis
- Protruded/caved-in breastbone
- Heart issues **
- Minor anomalies:
  - Joint mobility
  - High-arched palate
  - Narrow maxilla
  - Dolichocephaly
  - Retrognathia

HOW DOES THE CBFA1 GENE REGULATE TOOTH DEVELOPMENT?

EFFICIENCY / BURDEN OF TREATMENT?

Becker, Orthodontic Treatment of Impacted Teeth, Ch.14
Craniosynostosis premature closure 1(+) cranial suture
Frontal Bone Dysplasia
Midface Hypoplasia

6 y/o Craniotomy
10 y/o Maxillary Distraction

** GROWTH
yearly updates craniofacial team
1 / 2000 assoc. 130 syndromes / -

AJOCO 2012 April 141 S
Parameters of Care for Craniosynostosis: Dental and orthodontic perspectives
Unilateral mandibular hyperplasia?

Unilateral mandibular hypoplasia?

Hemifacial Microsomia?!
Etiology unknown; sporadic, hypodontia more prevalent
Manage expectations of orthodontics, referrals
Orthodontics, Surgery, Genioplasty, Soft Tissue Augmentations

Genes, genetics, and Class III malocclusion
Family based linkage and population based association analysis to identify genetic loci role in Class III malocclusion
Mandibular condylar hyperplasia?

Mandibular ramus hyperplasia?
Primary Failure of Eruption
12 year old male

high prevalence of hypodontia

DISTINGUISH PFE

- Eruption path cleared, no eruptive movement along path
- Teeth distal to most mesial affected tooth also involved
- Any or all posterior quadrants involved

PTH1R mutation is associated with failure of orthodontically assisted eruption or tooth movement

* TREAT PFE with caution — avoid treatment with a continuous arch wire be prepared in tx planning for ankylosis

Am J Orthod Dentofacial Orthop 2010;137, Frazier-Bowers et al
Tooth Genetic Diseases

Initiation → Morphogenesis → Differentiation

**Altered Tooth Number**
- Transcription Factors
  - Hypodontia: missing teeth
  - Hyperdontia: extra teeth

**Altered Tooth Structure**
- Extracellular Matrix Proteins
  - Amelogenesis Imperfecta
  - Dentinogenesis Imperfecta
  - Dentin Dysplasia

Early puberty, hypotelorism, Macrocephaly
Pinhead pits, enamel chips and abrasion
Yellow-brown, White-yellow?
hypoplasia with hypomineralization
Failure of eruption

Root resorption, impactions, eruption problems

**PHENOTYPIC VARIATION**
- Autosomal dominant gene with variable expressivity
- Etiologic heterogeneity

Autosomal Dominant Amelogenesis Imperfecta
Enamel Opacities / Defects

Amelogenesis Imperfecta
Trauma
Nutrition
Birth and Childhood Diseases
Teratogens
Fluoride

Radiographic variations

Tooth agenesis
anodontia, hypodontia, oligodontia

etiologic heterogeneity
  - genetic
    associated 47 syndromes (e.g. HED)
    single gene defect, often as AD trait with
    incomplete penetrance and variable expressivity
  - non-syndromic tooth agenesis:
    MSX1, PAX9, AXIN2, EDA, WNT10A
  - environmental
    trauma, radiation, chemotherapy

Oligodontia

Mutations in AXIN2 Cause Familial Tooth Agenesis and Predispose to Colorectal Cancer

J DENT RES April 2014
Oligodontia and Curly Hair Occur with Ectodysplasin-A Mutations

Anodontia: Complete failure teeth develop rare, AR
Oligodontia: absence of 6 or more permanent teeth
Hypodontia: absence of less than 6 permanent teeth
Incidence: including 3rd molars 20%, excluding 3rd molars 1.5-10% (5%)