Advances in Orthodontics: An Update for the General Practitioner

Gavin C. Heymann DDS, MS

Disclosure:
I do not have a financial interest in any of the companies whose products appear in this presentation.

Topics

General Trends
- Diagnosis & Treatment Planning
- Adult & Treatment Timing

Appliance Advances
- CAD / CAM technology
- Customized Appliances

Lasers
- Types
- Applications
- Protocols

Temporary Anchorage Devices (TADs)
- Types
- Applications

Diagnostic Advances
- 3D Imaging
- CBCT
- Digital Models

Accelerated Ortho
- Osseous Injury
- Vibration
- Photobiomodulation

General Trends in Contemporary Orthodontics

Diagnosis & Treatment Planning
- “Paradigm shift” in diagnosis and treatment planning
  - Greater focus on facial and smile esthetics
  - Treatment planning for soft tissue response
  - Trend towards fewer extractions

Changing Demographics
- Increasing proportion of orthodontic patients are adults
  - Increased focus on esthetic orthodontic treatment (Invisalign®, ceramic brackets, lingual braces)
  - Desire to shorten total treatment time and increase efficiency
  - Increasing need for complex interdisciplinary treatment
  - Greater focus on “limited objectives” treatments
Esthetic Enhancement in the age of the “Selfie”

- Ever-increasing emphasis placed on personal appearance
- Over $12 Billion spent annually on cosmetic surgical procedures
- Approx $3 Billion spent on cosmetic dental procedures
- Increasing desire for “quick fixes”

Adult Orthodontics: Meeting Patients’ Demands

- Emergence of Orthodontics as an “esthetic enhancement” procedure”
- “I don’t need perfect”
- Desires: Fast, Painless, Invisible, Cheap

Fewer Orthognathic Surgery Cases

- Fewer orthognathic surgery patients
  - Insurance approval issues
  - Necessitates “compromised” solutions to skeletal malocclusions

Contemporary Treatment Timing

- When should children have an orthodontic evaluation?
  - AAO recommends age 7
  - Most will not be ready
  - Allows for identification of problems that should be addressed early

Indications for Early Treatment

- Treatment in the mixed dentition warranted:
  - Posterior cross bite (particularly with functional shift)
  - Individual teeth anterior cross bites (wear)
  - Maxillary deficient class III
  - Ectopic eruption of maxillary first molars
  - Disturbances in normal eruption of permanent teeth
  - Skeletal class II with maxillary protrusion and/or psychosocial issues
  - Asymmetric crowding due to early loss of primary tooth
  - Alignment of anterior teeth to address esthetic concerns of patient/parent

Class II Treatment Timing

- When is the best time to treat Class II patients?
  - Several RCT’s have evaluated effectiveness and efficiency of treatment in one phase vs two
Class II Treatment Timing

- RCT findings:
  - After later comprehensive treatment, alignment and occlusion are very similar in children who did and did not have early treatment.
  - Early treatment does not reduce need for future extractions or orthognathic surgery.
  - Duration of second phase is similar in patients who had early tx and those who did not.
  - In most children, early treatment is no more effective than later treatment.
  - Since early treatment takes longer and costs more, it is less efficient.


So, when is the best time to treat Class II patients?

- Treatment should be timed to coincide with peak mandibular growth during adolescence.
- Early treatment (pre-adolescent) should be limited to severe cases and patients with esthetic or psychosocial concerns.

Advances in Orthodontic Appliances

- Goals:
  - Greater precision in achieving final position of teeth and occlusion—appliances are patient-specific.
  - Increased efficiency of treatment: excellent results in fewer appointments, and shorter total time.

Planning Treatment With the End Result in Mind

- Invisalign® set the stage for using digital set-up to plan the final clinical outcome and fabricate appliances.

Customized Appliances
Invisalign Setup vs Clinical Outcome

Diagnosis is the key

• Significant improvements have been made with Invisalign® system, however...
• Feasibility of proposed dental movements must be verified in advance
  – Planned treatment movements must fall within appropriate anatomic, occlusal, and soft tissue boundaries
  – Digital set-up / prediction is not always an accurate representation of what is clinically achievable

Customized (fixed) Appliances

• How are they different than non-customized appliances?
• Digital set-up of final desired occlusion used as blueprint for fabrication of appliances
• Approaches to achieve goal:
  – Individually customized brackets to accommodate use of straight wire
  – Individually customized arch wires to work in standard (non-customized) brackets
  – Customized brackets and arch wires

Rationale for Customized Appliances

Variation in tooth morphology

• Inter-individual variation in tooth morphology > variation in preadjusted appliance rx’s.

Methwe RR. AJODO 1999

Rationale for Customized Appliances

Variation in tooth morphology

• Factors that affect tooth inclination:
  – Facial surface contour variation
  – Vertical bracket position variation
  – Collum angle variation

Germane N. AJODO 1989
• Customized labial appliances with customized arch wires

• Customized arch wires used in non-custom brackets

• Fully customized lingual appliances with customized arch wires

**Accuracy of Customized Appliances Validation Studies**

How do the final results compare to the pre-tx set-up?

- Fully customized lingual appliances (Incognito)
  - Accuracy of +/- 5 degrees or < 1 mm of planned tooth positions
- Customized labial appliances (Insignia)
  - Lower average ABO score when compared to conventional appliances

Grauer D. AJODO 2011
Weber DJ. JCO 2013

Accuracy of Incognito Lingual Technique: Method and Evidence

Computer-Aided Design/Computer-Aided Manufacturing Technology in Customized Orthodontic Appliances

Journal of Esthetic and Restorative Dentistry January 2012
Lasers in Orthodontics

Common Dental Lasers

- **Erbium (YAG or YSGG)**
  - 2780-2940 nm wavelength
  - Can ablate soft and hard tissue
  - Tip held 1 mm from tissue—no tactile sense
- **Diode**
  - 810-980 nm wavelength
  - Ablate soft tissue only
  - Can be used in contact mode for tactile sense

Diode Laser Orthodontic Applications

- Access for bonding partially erupted teeth
- Canine exposure
- Operculum excision
- Esthetic gingivectomy
- Removal of redundant tissue due to poor OH
- Frenectomy
- Ablation of apthous ulcers

How Lasers Work

- Definition: Light Amplification by Stimulated Emission of Radiation
- Lasers "cut" by thermal ablation
- Cells undergo rapid heat absorption, melting, vaporization
- Thermal ablation depends on amount of light energy absorbed
- Degree of absorption is determined by wavelength of laser (nm), electrical power of unit (W), time of exposure, and composition of tissue
- Coagulates blood vessels, seals lymphatics, sterilizes wound
- Wavelengths of diode lasers are absorbed preferentially by darkly pigmented tissues (melanin)—highly absorbed by soft tissues and poorly by enamel and bone
Topical Anesthetic

- Profound PET
  - 10% Lidocaine
  - 10% Prilocaine
  - 4% Tetracaine
  - 2% Phenylephrine (vasoconstrictor)
  - Gel Thickener

- Made by compounding pharmacy
- Keep out of light
- Relatively short shelf life

Topical Anesthetic Protocol

- Review health hx for potential contraindications:
  - Hypersensitivity to amide or ester type local anesthetics
  - Para-aminobenzoic acid allergy
  - Severe hypertension
  - Hyperthyroidism
  - Heart disease
- Dry mucosa with gauze
- Dispense one pump of gel
- Apply with cotton swab
- Leave in contact with mucosa for 2 minutes
- Verify anesthesia with probe
- Remove excess gel
- Have patient rinse with water after completion of procedure
- Anesthetic duration is 20-30 minutes

Diode Laser Prep

- Must initiate or prime laser fiber optic tip (articulating paper or Sharpie)
- Priming concentrates heat energy at fiber optic tip to prepare for surgery

Diode Laser Precautions

- Patient and operator(s) must wear appropriate safety glasses
- High speed suction to remove plume

Diode Laser Settings

- For most applications:
  - 1.2-1.4 W
  - Pulsed beam mode
  - Tip to contact tissue
- Fibrous / dense tissue
  - 1.4-1.6 W
  - Continuous beam mode
  - Tip to contact tissue
- Aphthous ulcers
  - 0.5-0.8 W
  - Tip 1-2 mm from tissue
  - 30 second exposure
Canine Exposure Considerations

- Facially positioned canines are most amenable to laser exposure
- Essential to determine location of mucogingival junction
- Verify adequate inciso-gingival dimension of keratinized tissue
- Visualize planned surgical access
- Superior limit to surgical incision should remain 2-3 mm incisal to mucogingival junction

Esthetic Crown Lengthening Considerations

Altered Passive vs. Altered Active Eruption

**Clinical Appearance**: Excessive gingiva overlapping the enamel resulting in a short clinical crown.

**Altered Passive Eruption**: Failure of the tissue to migrate apically following active eruption.

**Altered Active Eruption**: Failure of the tooth to erupt through the bone to the proper occlusal/incisal level, thus impinging the gingival fiber apparatus and impeding its normal apical movement in the last stage of eruption.

Diagnosis is Key

- Where is CEJ relative to gingival margin?
- What is sulcus depth (ideally ~1mm ±)
- Where is osseous crest relative to CEJ (requires sounding)? (Ideally ~1 mm CT + 1 mm junctional epithelium = biologic width)
- Where is osseous crest relative to gingival margin? (Ideally ~3 mm)

1mm sulcus + 1mm junctional epithelium + 1mm to crestal bone

Diagnosis is Key

- Where is mucogingival junction?
- Answers to these questions dictate what treatment is appropriate

Altered Passive / Active Eruption

Gingivectomy
Gingivectomy & osseous reduction
Apical Repositioning
Apical Repositioning & osseous reduction


Temporary Anchorage Devices: TADs

- Types
  - Miniscrews
  - Miniplates
  - Palatal implants

Miniscrews

- Applications
  - Molar intrusion
  - Molar protraction
  - Anterior retraction
  - Class II correction (maxillary arch distalization)
  - Class III orthopedics
  - Occlusal plane cants
  - Others

Class III Orthopedic Treatment (maxillary protraction) in pre-adolescent patients
Skeletal Class III Malocclusion

Prognathic Mandible

Retrusive Maxilla

Combination Max and Mand

The Conventional Treatment

Protrusion facemask / Reverse Pull Headgear (RPHG)

Problems:

• Cumbersome appliance
• Excellent compliance is difficult to achieve
• Forces applied directly to teeth; resultant dentoalveolar compensation

New Approach: BAMP

(Bone Anchored Maxillary Protraction)

Diagnostic Advances

• 3 Dimensional Imaging
  – CBCT
  – 3D photography
  – Digital models

Cone Beam Computed Tomography (CBCT)

Orthodontic Applications:

• 3D assessment of craniofacial anomalies, skeletal asymmetry
• Localization of impacted teeth
• Pre-surgical planning for orthognathic procedures and miniscrew placement
• 3D comparison of treatment outcomes or growth (research)
3D Assessment of Treatment or Growth Effects

Superimposition of 3-dimensional cone-beam computed tomography models of growing patients.

Lucinda K. Daniels, Janis Hogeboom, Elaine de la Cueva, Hugo A. de Cos, and K. Chevally Tolbert

Introduction: The objective of the study was to evaluate a new method for superimposition of 3-dimensional 3DC models of growing patients. Methods: Six adult cone-beam computed tomography scans were obtained from patients undergoing orthodontic treatment. The 3DC models were constructed from Orthoan imaging software. The 3DC models were then superimposed using a software package designed for this purpose. Results: The software allowed for a precise and accurate superimposition of the models. Conclusion: This method provides a valuable tool for monitoring growth and treatment progress in orthodontic patients.

CBCT for Ortho Purposes Risk vs Benefit

Is it worth it?

Evidence supporting the use of computed tomography in ortho

Conclusions

There is no high-quality evidence regarding the benefits of CT scans in orthodontics. The additional radiation exposure and cost of CT scans may outweigh the benefits in some cases, but it is not always the answer to all clinical problems. Limited evidence has been found that CBCT offers better diagnostic potential, leads to better treatment planning and results in better treatment outcomes than conventional 2D X-ray imaging. Only the evidence-based and methodically sound scientific research data can support the use of CBCT. The additional radiation exposure associated with a CBCT scan compared to that associated with a conventional 2D X-ray should be weighed against each other at the time of treatment planning.

Get a second opinion.

Your doctor asks if you have a financial interest in an imaging center. As an office CT might seem convenient, it causes anxiety and may impair patient control or care. And there’s little doubt that the need for scans in a diagnostic imaging center is more than just a matter of convenience. Is your next best option to get a second opinion? Or is it just another attempt to knock off another preventable disease? And if the treatment costs are low or if there’s a financial affinity with the new technology, are another 3-D imaging experiments worth it?

Your doctor recommends a "whole-body" CT scan.

These scans are often needed to detect rare signs of cancer and heart disease. But most patients go to one hospital, where people have been examined for years, and then to another hospital, where people have been examined for years. In the presence of such overlaps, it's not clear if the additional radiation is worth the cost. CT scans are also frequently performed in the same imaging center as other tests, so the need for additional scans may not always be clear.

Your dental consortium recommends a 3D dental X-ray.

The context behind the concern is about the potential for radiation exposure. The American Dental Association says that children need less radiation compared to adults. And some experts have even formed a group called the "Radiation Advisory Task Force" to try to limit the amount of radiation children get. But in the end, it’s up to the individual to decide if the benefits outweigh the risks.
The End of Impressions?

- Fabrication of digital models and appliances (aligners, retainers, brackets, arch wires, etc.) from intraoral scan or CBCT

Digital Models

- Eliminate need for physical storage space
- Ability to create digital set-ups
- Can be used for indirect bonding set-ups
- Easily shared with other dentists via email
- Potential integration with CBCT data

Digital Models: Accuracy

- Linear measurements can be made on digital models created from:
  - Scan of physical impression or model
  - Intraoral scan
  - CBCT data
- Accuracy of linear measurements appear to be clinically acceptable for all 3 approaches

Diagnostic setups in the digital age: A new gold standard?

- Various softwares allow for digital setup of teeth
- Helpful in diagnosing tooth size discrepancies pre-tx
- Caution must be used to avoid parallax effect

3D Printing

Workflows

Scan ➔ Digital model ➔ 3D Printer ➔ Physical model

Concern for the Future

- Potential for companies to bypass practitioners and interact directly with consumers?
  - Have “tooth-whitening kiosks” at malls, etc. set a precedence?
**DIY Orthodontics**

- Alarming recent trend of orthodontic self-treatment
  - 3D printing technology offers potential for “DIY clear aligners”

**Accelerated Tooth Movement**

- Emergence of techniques aimed to increase speed of tooth movement by modification of physiologic response
  - Osseous injury to leverage Regional Acceleratory Phenomenon (RAP)
  - Micro-pulse vibration to leverage piezoelectric or bioelectric potential
  - Low-level light therapy (photobiomodulation) to promote connective tissue and bone remodeling

**Regional Acceleratory Phenomenon (RAP)**

- Definition: an increase in metabolic activities in hard and soft tissues (including modeling and remodeling activity in the skeleton) that is initiated by a provocative stimulus (fracture, etc.)

**Accelerated Osteogenic Orthodontics (AOO)**

- Full thickness facial and lingual flaps reflected
- Corticotomies around tooth roots and perforations over roots
- Particulate bone grafting material over decorticated areas

**Modified Corticotomy (Piezocision)**

- Multiple vertical incisions between tooth roots (no flaps reflected)
- Corticotomies made with piezotome
- Bone grafting material placed via soft tissue tunnel
Accelerated Tooth Movement: What does the literature say?

- 18 articles of low-moderate quality
- All reported temporarily accelerated tooth movement
- No deleterious effects on periodontium
- No studies that evaluate stability
- No prospective studies or those with controls

Coritcal Microperforation

- Allows for transmucosal cortical punctures of various depths
- No incisions required
- Multiple perforations in interproximal regions

High Frequency Vibration

- 30 Hz vibration delivered via individual intraoral device
- 20 minutes per day
- Stimulation of cell differentiation and maturation occurs more quickly

Photobiomodulation

- Intraoral device that emits continuous tissue-penetrating red or near infrared light (850 nm)
- 10 minutes per day
- Stimulation of osteoclastic mitochondria causes production of increased ATP, more rapid bone remodeling, and accelerated tooth movement

Accelerated Tooth Movement

- Do these techniques work?
  - Pretty clear that invasive approaches that leverage RAP do increase speed of tooth movement
  - But for how long?
  - Cost vs Benefit?
  - No evidence exists to support increase in stability of expansion
  - Absence of high level evidence to support efficacy of vibration and light exposure
  - All approaches need more evaluation

Conclusions

- New technologies are helping to improve diagnosis, treatment planning, treatment efficiency, and treatment outcomes of orthodontic patients
- None of these tools supersede sound diagnosis, treatment planning, and clinical judgment