Evidence for Accelerated Orthodontics

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Why????

- Oral hygiene problems, white spot lesions, caries...
  - Fisher et al., 2010
- Periodontal disease
- Prolonged treatment time
  - Correlated to root resorption
    - Segal et al., 2004
  - Compliance decreases
    - Royko et al., 1999
Why?

Demand from patients for faster orthodontic treatment
Advantages

- Less relapse?
- Increased scope of malocclusion correction
- Reduced treatment time
Accelerating Tooth Movement

- Periodontally Accelerated Osteogenic Orthodontics
- Micro-osteoperforations
- Periodontal Tissue Activation by Vibration
- Gene Therapy
- Laser Irradiation
- Magnetic Fields
- Injection of Prostaglandin E₂
- Photobiomodulation
Empirical Methods for Clinical Decision Making

Dogmatism  Policy
Experience  Whim
Nihilism  Rule of Least Chagrin
Defer to Experts  Defer to patients

Friedland et al., 1998
Controls

• Osteoclast Activity

• Rate of Bone Resorption

• Rate of Tooth Movement

Controls

Controls
Periodontal Tissue Activation by Vibration
In the Medical Literature

- Low magnitude mechanical signals stimulate bone formation
  - Turner et al., 1992
  - Rubin et al., 1995
  - Rubin et al., 2001
  - Rubin et al., 2004
  - Holguin et al., 2009
  - Wang et al., 2012

- Improve and maintain bone and/or muscle mass
  - Gilsanz et al., 2006
  - Gusi et al., 2006
  - Ward et al., 2004

- Non-invasive

- Non-pharmacological
Periodontal Tissue Activation by Vibration

1. Resonance vibrational stimulation of teeth and periodontal tissues
2. Activity of PDL cells increase
3. Acceleration of tooth movement

Nishimura et al., 2008
Faster tooth movement by Vibration

- Vibrational forces may be reducing frictional resistance between bracket and arches
  - Olson et al., 2012
  - Seo et al., 2014
Tooth Masseuse

“Alright, so it's bad enough you gotta wear braces, but to add injury to insult there's always the pain of the orthodontic treatment to deal with, as well. The Tooth Masseuse aims to eliminate or at least greatly reduce the pain from the treatments with soothing vibrations. Set the device for "high" or "low" depending on the level of soothe you're in need of, and gently bite down on the device for 15 minutes following a treatment. It's only $34.95 and apparently can't be overused, so what're ya waiting for?”
Tooth Movement and Discomfort Using a Vibrational device

- 66 patients
- Randomized controlled trial
- Experimental group
  - Vibrational device for minimum of 20 minutes/day
- .014 Niti during a 10 week study period
- Mandibular impressions taken at start, 5 weeks, 8 weeks, and 10 weeks.
- No significant differences in irregularity reduction or pain levels.

Miles et al., 2012
Effect of resonance vibration on tooth movement and root resorption in rats (Nishimura et al., 2008)

- Niti spring placed between maxillary right and first molars to move these molars buccally
  - Controls (No resonance vibration)
  - Resonance vibration group
Effect of resonance vibration on tooth movement and root resorption in rats (Nishimura et al., 2008)

- Niti spring placed between maxillary right and first molars to move these molars buccally
- Controls (No resonance vibration)
- Resonance vibration group
- Displacement measured on days 0, 3, 7, 10, 14, 17, 21
- Superimposition of contours of the molars
- Histological examinations
Effect of resonance vibration on tooth movement and root resorption in rats (Nishimura et al., 2008)

- Niti spring placed between maxillary right and first molars to move these molars buccally
  - Significant difference in tooth movement
  - No significance in root resorption between the two groups
  - No collateral damage to the periodontal tissues
  - Signaling molecules increased in the PDL after the mechanical stimulation
    - C-fos ↑
    - MAPK ↑
    - Nitric oxide ↑
How do we apply vibrational stimulation in a clinical setting?

- Length and interval of application
- Cost-effectiveness
- Period of time required to activate the PDL
  - 8 minutes
  - Once a week
Effect of Cyclical Forces on the PDL

Kalajzic et al., 2014
- 26 rats
  - Controls
  - Molars receiving vibratory stimulus only
  - Molars receiving a spring only
  - Molars receiving spring and vibratory stimulus
- Forces at 0.4 N and 30 Hz
- Twice a week for 10 minutes
- Inhibition of tooth movement!!!
Acceledent

- 20 minutes/day
Preliminary AcceleDent Study

- 14 subjects
- 20 minutes/day for 6 months
- No controls
- 3 mm/month in the maxilla
- 2.1 mm/month in the mandible
Acceledent Increases the Rate of Orthodontic Tooth Movement

Results of a Randomized Clinical Trial
November 2011
Randomized Clinical Trial

- Crowding in the maxillary arch requiring at least one first premolar extraction
  - 23 subjects with Acceledent
  - 22 controls with the sham appliance

- During alignment, tooth movement was 2 times faster in the Acceledent group.

- During space closure tooth movement was 38% faster in the Acceledent group.
  - 0.29 mm/week in Acceledent group
  - 0.21 mm/week in the control group
  - P<0.02
Cyclic Loading (vibration) accelerates tooth movement in orthodontic patients: A double-blind, randomized control trial

Pavlin et al., 2015 (Seminars in Orthodontics)
Acceledent increases rate of tooth movement
Supplemental Vibrational Force During Orthodontic Alignment

- Randomized Clinical Trial
- Investigation of the effect of vibrational force (AcceleDent) on rate of orthodontic tooth alignment with fixed appliances

- 81 subjects
  - 40 males, 41 females
  - Mean age 14.1
  - Four first premolar extractions

Woodhouse et al., 2015 (May, Journal of Dental Research)
Supplemental Vibrational Force During Orthodontic Alignment

- Groups
  - Fixed appliance with AcceleDent (n=29)
  - Fixed appliances with sham AcceleDent (n=25)
  - Fixed appliances only (n=27)

Woodhouse et al., 2015 (May)
Supplemental Vibrational Force During Orthodontic Alignment

- Rates of orthodontic alignment was not significantly different among the 3 groups

- Changes in Little’s Irregularity Index NS
  - AcceleDent—8.4 mm
  - Sham—7.6 mm
  - Fixed appliances only—8.6 mm

- Alignment time was not statistically significant among groups

Woodhouse et al., 2015 (May)
Pain Control with AcceleDent

- Lobre et al., 2014
  - Significantly lowered pain scores for overall and biting pain during the 4 month study period

- Woodhouse et al, 2015
  - No significant reduction in pain
Supplemental vibrational force does not reduce pain during initial alignment with orthodontic fixed appliances.

No significant differences existed between the groups using 100 mm VAS.

Woodhouse et al., 2015 (November)
Effect of Supplemental Vibrational Force on Orthodontically Induced Inflammatory Root Resorption: a multicenter RCT

- OIRR measured from periodical radiographs of UR1 taken at start and end of alignment.
- Mean OIRR 1.08 mm
- No significant difference between the groups
  - Acceledent vs fixed appliance controls: .22mm difference
  - Acceledent sham vs fixed appliance controls: .29 mm

DiBiase and Woodhouse et al., 2016 (December)
Assessment of the changes in arch perimeter and irregularity in the mandibular arch during initial alignment with the AcceleDent Aura appliance vs no appliance in adolescents: A single-blind randomized clinical trial

“The AcceleDent Aura appliance had no effect compared with no appliance on increasing anterior arch perimeter, or reducing irregularity or perceived discomfort during initial alignment with fixed appliances, although more subjects used painkillers at 24 hours in the no-appliance group.”

Miles and Fisher, 2016 (December)
Children up to age 16 years old having fixed appliance orthodontics for a Class II malocclusion requiring extraction of two first premolars. (20 in each group)

- AcceleDent Aura used for 20 minutes per day
- Treatment as usual, no AcceleDent
- Change in mandibular arch perimeter and Irregularity Index in a 10 week period measured from study casts. The secondary outcome was discomfort and analgesic intake.

Miles and Fisher, 2016 (December)
Acceledent and Invisalign

Katchooi et al, 2018

- RCT of 27 subjects
- Acceledent group
- Controls—sham appliance

- Acceledent had no effect on alignment when used in conjunction with Invisalign.
- No significant effect on reduction of pain.
I am concerned that practitioners are promoting this technology in the absence of good evidence. This is because the AcceleDent appliance must cost the patient money. There is now increasing evidence that may cast doubt on the effectiveness of AcceleDent. In this respect, I wonder if orthodontists can keep promoting this product? Finally, it would be great if some of the AcceleDent Key Opinion Leaders could comment on this paper.
Acceledent Optima versus Aura

- Optima is new!
- Reduction in size with Optima
- Additional tools for tracking
- Uses SoftPulse Technology
High or Low Frequency

- Sonic Vibrations
  - Low frequency 30-40HZ
    - Bitepod
  - High frequency 125 Hz
    - Viber125
    - Vpro +

- Improve Oral Hygiene
- Reduce Pressure and Pain
- Increase Cooperation
- Enhance Treatment
- Help Seat Aligners
- Works with Fixed Braces or Aligners
Micro-osteoperforations
Micro-osteoperforations and Rate of Tooth Movement

- To study the rate of canine retraction after extractions of upper first premolars with /without micro-osteoperforations

- Randomized Clinical Trial
  - Class II Division 1 –similar severities of malocclusion
  - 20 patients
    - 10 experimental
    - 10 controls
  - Age range 19.1-33.1; Mean of 24.7 years for controls and 26.8 for subjects
Micro-osteoperforations (MOP)

- 3 MOPs in the extraction space at equal distances from canine and the second premolar.
- 1.5 mm wide; 2-3 mm deep
- MOP appliance by Propel Orthodontics
Micro-osteoperforations and Rate of Tooth Movement

- Significant increase in the expression of cytokines and chemokines
- Canine retraction increased 2.3 times in the experimental group vs. controls.
- No significant differences between the groups for pain.
Microosteoperforations accelerate tooth movement in rats

- 5 MOPs (using mini-implants) placed on the left side around the maxillary first molars in rats
- Right side no MOPs—controls
- Coil springs from incisors to first molars
- Tooth movement measured
  - MOP side has 1.86 fold increase in the rate of tooth movement.
  - Increase in osteoclasts

Cheung and Park et al., 2016
Micro-osteoperforations and Tooth Movement

- Increase in tooth movement by MOPs
  - Alikhani et al., 2013
  - Asif et al., 2020

- No significant increase by MOPs
  - Fleming et al., 2015 (Cochrane review)
  - Alkebsi et al., 2018 (RCT)
  - Fu et al., 2019 {Systematic review (Cochrane)}
Alveocentesis with Propel

- Increase in cytokine expression
- Increase in rate of bone remodeling
- Decrease in bone density

- Frost et al., 1988
- Shih et al., 1985
The PROPEL Device

Adjustable Depth Dial

Depth stop indicator

Retractable Sleeve
Conclusion

Orthodontic forces → Inflammation → Cytokines → Bone remodeling → Tooth movement → Osteoperforation → Bone remodeling → Tooth movement → Osteoblasts → Osteoclasts → Fibroblasts → TNF

Cytokines: IL-1α, IL-6, IL-18, TNF

Bone remodeling and Tooth movement result in increased Cytokines, which leads to Inflammation and further increases in Cytokines and Bone remodeling. This process is associated with Osteoclasts and Osteoblasts, as well as Fibroblasts and TNF, indicating a complex interplay of cell types and inflammatory signaling in the bone remodeling process induced by Orthodontic forces.
Application

- Panoramic radiograph
- Palpation
- Visual assessment
- Topical anesthetic or local anesthetic
- 2-3 micro-osteoperforations mesial and distal to the targeted location
3 micro-perforations are placed interproximally starting above the gingival margin then moving up toward apex.

Two apical and one gingival as anatomy allows OR three placed vertically.
The Propel Excelleration Series

Excellerator

Excellerator RT
Key Features

- Depth limiter with LED indicator
- Patented pitch on leading edge
- Proprietary surgical steel construction
- Conveniently packaged for single use
- Ergonomic design for enhanced tactile sensation and control
- Higher helix thread pitch
- Soft retractable sleeve mechanism to hold tissue taut
The Excellerator RT

Key Features
- 2 disposable tip options provide enhanced clinical accessibility
- Large handle with textured grip for increased stability and control
- Proprietary tip construction ensures consistent integrity for maximum number of Micro-Osteoperforations
- Sterilizable handle reduces material waste
- Unique flute angle minimizes soft tissue impact
Sequential Piezocision
Piezocision

- Use of a piezoelectric knife
  - Decreases surgical trauma
  - Achieves rapid tooth movement

- Allows for grafting to correct gingival recessions and bone deficiencies
Piezocision Steps

- Performed 1 week after bonding
- Vertical interproximal incisions with Piezosurgical knife to a depth of 3 mm.
- Tunneling with a periosteal elevator through the vertical incisions if grafting is needed.
- Adjustments every two weeks
Piezocision

- Tissue turnover adjacent to the surgical incisions.
- Teeth away from the surgical site may be used for anchorage.
- Application of higher forces than conventional orthodontic treatment
- Transient tooth mobility
Advantages of Piezocision

- Safety
  - Safer than corticotomies performed with burs
    - Robiony et al., 2004
    - Kotrikova et al., 2006
    - May increase root resorption
      - Patterson et al., 2017
  - Possible to do bone grafts
  - Minimally invasive
  - Invisalign cases
    - Keser et al., 2011
Localized Piezoelectric Alveolar Decortication for Orthodontic Treatment in Adults

- 24 adult patients with mild crowding randomly assigned to
  - Control group—conventional ortho treatment
  - Test group—piezo-assisted orthodontics
    - 1 week after bonding appointment
    - 5 mm long and 3 mm deep corticotomies
  - Definition of end of treatment
    - Class I
    - Complete correction of crowding
    - Optimal overjet and overbite
    - Coincident upper/lower midlines
    - Occlusion according to 6 keys of Andrews

Charavet et al., 2016
Localized Piezoelectric Alveolar Decortication for Orthodontic Treatment in Adults

- Gingival recession, bone dehiscence and increase in root resorption not observed.
- Remaining scars
- High level of patient acceptance and satisfaction
- Promising new treatment option with 43% reduction in treatment time
  - 330 days for piezocision group, 550 days for controls
- Limitations
  - Small sample
  - Mild malocclusion
  - Data not clearly presented

Charavet et al., 2016
Efficiency of piezotome-corticision assisted orthodontics in alleviating mandibular anterior crowding—a randomized clinical trial

- Adult orthodontic patients with mandibular crowding
- Non-extraction treatment
- Self-ligating brackets
- Piezotome corticision
- No intervention (treatment w/o piezotome corticision)

Outcome

- Time to alignment (alignment defined as Little’s irregularity index of less than 2mm)

Uribe et al., 2017
Efficiency of piezotome-corticision assisted orthodontics in alleviating mandibular anterior crowding—a randomized clinical trial

- No differences between groups at treatment start.
- Outcome

<table>
<thead>
<tr>
<th>Alignment</th>
<th>Piezocision</th>
<th>Control</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days</td>
<td>102</td>
<td>112</td>
<td>-10</td>
</tr>
</tbody>
</table>

- Follow-up till the end of alignment
- IRB felt that “recommended” treatment carried significant risk.
- No evidence that piezocision is more efficient than conventional orthodontics.

Uribe et al., 2017
Piezocision

- Afzal et al., 2020
  - Systematic Review
    - 6 RCT’s/2 non-RCT’s
    - Outcome: Rate of alignment
    - Effective in reducing time to align teeth
    - Insignificant differences in pain.
    - No negative effects on periodontal health and no root resorption (weak evidence)
Piezocision

- Afzal et al., 2020
  - Faster alignment with piezocision
    - Charavet et al., 2016
    - Yavuz et al., 2018
    - Strippoli et al., 2019
    - Gibreal et al., 2019
  - No significant differences in alignment time with piezocision
    - Mehr et al., 2013
    - Uribe et al., 2017
Application of light in the near infrared wavelength (800-1000 nm)

- Infusion of light energy into the bone tissue
- Energy absorbed by mitochondria
- Converted to ATP
- Increase in remodeling
Clinical Research

- Faster tooth movement
  - Kau et al., 2013
    - 73 test subjects (1.12 /week)
    - 17 controls (0.49 mm/week)
    - 2.3 times faster mean alignment rate
  - Chung et al, 2015
    - Split mouth design RCT
    - Orthopulse versus inactive light source to different quarters during space closure
    - 11 patients
    - 0.042 mm/week (treated) vs 0.039 mm/week (controls)—not significant

Ekizer et al., 2016

- Split mouth design
- 20 patients
- Acceleration in tooth movement
Intra-oral photobiomodulation-induced orthodontic tooth alignment: a preliminary study

- Null hypothesis
  - No difference in the rate of orthodontic anterior alignment between PBM and controls
  - 8 controls and 11 cases
  - Treated with different brackets
  - Not random allocation
  - Follow-up until initial alignment
  - Small sample size

Shaughnessy et al., 2016
- No clinically significant root resorption
  - Nimeri et al., 2014
    - No controls
RCT—photobiomodulation

- Decrowding of lower anterior segment with and without photobiomodulation: a single center, randomized clinical trial.

- 20 patients en each group
  - Self-ligating bracket with ortho-pulse
  - Self-ligating brackets without fortho-pulse

- Ortho pulse group 68.3 days
- Control group 87.8 days

- Statistically significant at $P=0.04$ and very large standard deviations

Nahaz et al., 2017
Photobiomodulation

- Cronshaw et al., 2019
  - Systematic review
  - 9 studies investigating reduction in pain
    - 7 showed effectiveness of photobiomodulations in pain reduction.
  - 7 studies investigating tooth movement
    - 4 showed significant tooth movement with photobiomodulation
  - Further studies required
Low Level Laser Therapy Effectiveness

- 26 patients
- Premolar extractions
- Laser application repeated on days 3, 7, 14, and then every 15 days until the end of leveling and alignment stage.
- Outcome: Overall time needed for leveling and alignment.
- LLLT is an effective method
  - 81.23 in LLLT group versus 109.23 days in controls

Moaffak et al., 2016
Patient perceptions

- Treatment time
- Treatment cost
- Discomfort

Uribe et al., 2014
- 70% of orthodontists were interested in changing treatment to reduce treatment time
- Concerns about fee collection with reduced treatment time
- Patients are willing to pay 20% more for reduced treatment time
- Less invasive techniques are more acceptable for patients.
Evidence for Accelerated Orthodontics
Reprise: Very rapid orthodontic treatment

“The impression is made upon the lay mind that the orthodontist who makes no claims to supply this extraordinarily high speed treatment in 2016 either is hopelessly antiquated in his methods and technic or deliberately draws out the treatment indefinitely for purposes best known to himself. “

“The main trouble seems to be that enthusiasm over rapid treatment, especially among inexperienced men, is responsible for grossly exaggerated reports which, after being told a few times, become first increasingly exaggerated, then ridiculous.”

“In fact the majority of orthodontists have heard informal tales for a number of years, and they listen to stories of voodoo treatment complacently, with an attitude, more or less of “important if true.”

“…..this “gilding of the lily” to the laymen will be discounted by the majority of the orthodontists of the world as purely professional promotion and sales propaganda.”

“There is no unusual, extraordinary, or secret method for correction of a malocclusion other than the hard work and close application to detail, with a thorough understanding and knowledge of the fundamentals of the subject. Without these, relapse is the ghost that walks in the night, notwithstanding the variation in types of appliances or the time utilized.”
In Summary

- Many different methods
- Based on the same assumption
- Enthusiasm
- We need more evidence!