Sleep Apnea and its Impact on Diagnosis and Treatment Planning

Michael O. Williams, DDS
Gulfport, Mississippi
“The Effect of Mandibular Position on Appendage Muscle Strength”

Michael O. Williams, D.D.S.
Spiro J. Chaconas, D.D.S., MS
Philip Bader, D.D.S., MS

The Journal of Prosthetic Dentistry
Volume 49  number 4
1983
ABDUCTORS & ADDUCTORS

REST

E-TT

P=0.22

R-TT

P=0.02

R-E

P=0.04

EXTENDED

TEETH TOGETHER
Results

“The balanced rest position scored the highest mean value over the teeth together and the extended vertical position for all muscle groups tested.”
1. “Head posture and Craniofacial Morphology”

Ben Solow, and A. Tallgren

Amer. Journal Physical Anthropology

Volume 44  pp. 417-436  1976
2. “Dentoalveolar Morphology in Relation to Craniocervical Posture.”

B. Solow and A. Tallgren

The Angle Orthodontist

Volume 47 pp. 157-163 1977
Aim: Less tension, increased airflow

By J. Michael Falgoust
USA TODAY

Fatigue can be as much psychological as it is physical, especially for an NFL lineman who weighs in excess of 300 pounds late in a 16-game season.

Cover story

After misplacing his neuromuscular mouth guard for a few games, Derrick Dockery, a 6-6 guard now in his second stint with the Washington Redskins, immediately recognized the difference.

Or so he thinks.

"The hardest part is to distinguish if it’s psychological," Dockery says. "Is it? . . . I got more winded the games I didn’t have it in compared to the games I did have it.

"My breathing felt different when I wore it. It seems like you have more energy."

All mouth guards are designed to direct and distribute the impact of force to the jaw to minimize injuries such as lacerations, damaged teeth and concussions. Neuromuscular mouth guards are different from the traditional boil-and-bite ones that can be purchased at sporting goods stores and even from the custom-fitted ones dentists often make for individual players of pro sports teams.

Rather than focusing on the pre-existing relationship where the teeth come together and the jaw joints set in the sockets to find the bite like traditional dentists, neuromuscular dentists relax the muscles for a "verifiable position" that usually results in a joint socket position that’s typically more down and forward.

"If you pull the jaw forward, your tongue is forward, you have more space in the back. It’s that simple," says AestheticDentalSpa.net’s Alex Naini, a neuromuscular dentist in Vienna, Va., outside Washington, D.C., who fitted Dockery. "Anything that

Wearer: Shaquille O’Neal has a neuromuscular guard.
Gnathological Occlusion

Ideal Condylar Position: relates to definition of Centric Relation and how that position relates to Centric Occlusion
Neuromuscular Occlusion

“Applying the Neuromuscular Principles in TMD and Orthodontics”

Clayton A. Chan, D.D.S.

The Journal of the American Orthodontic Society
Spring
2004
“To be shaken out of the ruts of ordinary perception . . . is an experience of inestimable value. . . .”

ALDOUS HUXLEY

The Doors of Perception
Keys to Success

1. Diagnosis
2. Treatment Planning
Diagnosis and Treatment Planning are the keys to SUCCESS !!!
Keys to Success

1. Diagnosis
The Diagnosis Determines The Treatment Plan
DIAGNOSIS

• Initial Examination
• Radiographic And Cephalometric Analysis
• Model Analysis
• Soft Tissue And Profile Analysis
DIAGNOSIS

INITIAL EXAMINATION
DESIGN A

COMPREHENSIVE EXAMINATION FORM

...AND FOLLOW IT!
Clinical Examination

- Patient History
- Respiration
- Lip Competence
- Deglutition
- Facial Form
- Intraoral Examination
Evaluate Facial Symmetry and Lip Posture

BEFORE STARTING
“THE ORTHODONTIST’S RESPONSIBILITY IN PREVENTING FACIAL DEFORMITY”

ROBERT M. RUBIN, D.D.S., M.S.

Norfolk, Virginia
Clinical Examination

- Patient History
- Respiration
- Lip Competence
- Deglutition
- Facial Form
Frequent Respiratory Infection

Nasal Septum Deviation

Contracted Maxillary Arch

Enlarged Adenoids

Swollen Nasal Mucosa

Reduced Nasal Breathing

Decrease in Nasal Width

Mouth Breathing

Lowered Tongue Position

Extended Head Posture

Lowered Mandibular Posture
Figure 17. Difference in facial morphology of monozygotic twins, one of which had obstructed nosebreathing capacity (courtesy of Dr. Robert Bushey).
Craniocervical Angulation
And
Nasal Respiratory Resistance

Beni Solow, dr. odont.
Ellen Greve, dr. odont.

Institute of Orthodontics
The Royal Dental College
Copenhagen, Denmark
Obstruction of Respiratory Tract
(i.e., Nasal plugs, large adenoids)

Increased Resistance of Respiratory Tract

Transient Decrease of Airflow

Transient Decrease of Oxygen (Hypoxia) and Increase of Carbon Dioxide (Hypercapnia) in Blood

Alter Sensory Feedback from Carotid and Aortic Bodies and Medullary Chemoreceptor Site

Central Respiratory Pathway Increases Work (i.e., Pulmonary Ventilation)

Primary Respiratory Muscles Increase Activity

Recruit Accessory Respiratory Muscles

Increase Airflow by using Oral Cavity

Alteration of Neuromuscular Function of Craniofacial Muscles

Alter Position of Mandible and Tongue

Alter Soft Tissue (i.e., Upper lip, Tongue)

Alter Cranio-skeletal Form

© DynaFlex® - Michael Williams
Neuromuscular and Morphological Adaptations in Experimentally Induced Oral Respiration

Egil P. Harvold, DDS, PhD, LLD

Center for Craniofacial Anomalies
University of California
Neuromuscular Changes Following Altered Respiration
INDUCEMENT OF TONIC DISCHARGE IN
CRANIOFACIAL MUSCLES AFTER NASAL OBSTRUCTION

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“Changing muscle activity will affect bone morphology...”

applies to the use of functional appliances
Nasal Obstruction Effects Skeletodental Growth

- Lip Incompetence
- Mouth Breathing
- Nasal Obstruction
- Growth Modification
  - Deficient Maxilla
  - High Narrow Vault
  - Open Bite
  - Long Face Syndrome
Clinical Examination

- Patient History
- Respiration
- Lip Competence
- Deglutition
- Facial Form
- Intraoral Examination
Effects on the Dentition and Facial Skeleton
Change in Mode of Respiration
Mouth to Nasal Breathing

Areas of Evaluation:

1. Upper and Lower incisor inclination
2. Upper arch Width
3. Sagittal Depth of Nasopharynx
4. Anterior Face Height
5. Inclination of Mandible to Maxilla
Offenders in Respiratory Allergy

- Windborne Pollen
- Fungus Spores
- Arthropod Emanations
- House dust and House dust mites
- Animal Danders
- Additional Organic Dusts
- Ingestants
# Tonsils and Adenoids

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<th>Degree of Obstruction</th>
<th>Known Cardiorespiratory Complications</th>
<th>Possible or potential Complications &amp; Sequelae</th>
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<td>Effect on Pulmonary Ventilation</td>
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<td>Alveolar Hypoventilation</td>
<td>Effect on Cranio- and Dentofacial Morphology</td>
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<td>Moderate</td>
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<td>Abnormal Speech</td>
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<td>Cor Pulmonale</td>
<td>Decreased or Absent Olfaction</td>
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<td>Severe</td>
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<td>Retardation of Growth And Development</td>
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<td>Nasal and Paranasal Sinus Disease</td>
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<td>Middle Ear Disease</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cognition, School Performance Pyscho-social Abnormalities</td>
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</table>
PATHOPHYSIOLOGY OF COR PULMONALE DUE TO TONSILS AND/OR ADENOIDs

- Obstruction of the nasopharynx due to adenoids and/or oropharynx due to tonsils
- Increased upper airway resistance
- Increased O2 cost of breathing
- Decreased ventilatory capacity

- Alveolar hypoventilation
- Pulmonary vasoconstriction
- Pulmonary hypertension
- Right-sided heart decompensation
- Pulmonary edema
- Congestive heart disease
DIAGNOSIS

• INITIAL EXAMINATION

• RADIOGRAPHIC AND CEPHALOMETRIC ANALYSIS
Orthodontic Radiographic Series for a Non-TMD Patient

- PANORAMIC RADIOGRAPH
- LATERAL CEPHALOGRAM
- POSTERIOR / ANTERIOR CEPHALOGRAM
- WRIST FILM
Orthodontic Radiographic Series for a Non-TMD Patient

- LATERAL CEPHALOGRAM
LATERAL CEPHALOLOGRAM

- FACIAL PATTERN
- ANTERIOR POSTERIOR DISCREPANCY
- AIRWAY EVALUATION
LATERAL CEPHALOGRAM

• FACIAL PATTERN
FACIAL PATTERN

- FACIAL AXIS
- MANDIBULAR PLANE
- LOWER FACE HEIGHT
- MANDIBULAR ARC
FACIAL PATTERN

- FACIAL AXIS
Facial Axis Angle

Fig. 10A: Facial Axis Angle represents the direction of mandible movement.
FACIAL PATTERN

• FACIAL AXIS
• MANDIBULAR PLANE
Mandibular Plane Angle

Fig. 504: Mandibular Plane Angle illustrates the normal growth of the roots of the mandible and is measured with various indices and techniques.
FACIAL PATTERN

- FACIAL AXIS
- MANDIBULAR PLANE
- LOWER FACE HEIGHT
Fig. 107  Lower Face Height illustrates vertical dimension problem
FACIAL PATTERN

- MANDIBULAR PLANE
- FACIAL AXIS
- LOWER FACE HEIGHT
- MANDIBULAR ARC
Fig. 320. Mandibular Arc: Structures of mid-facial region.
LATERAL CEPHALOGRAM

- FACIAL PATTERN
- ANTERIOR POSTERIOR DISCREPANCY
ANTERIOR-POSTERIOR DISCREPANCY

- FACIAL DEPTH
- MAXILLARY DEPTH
- CONVEXITY
ANTERIOR-POSTERIOR DISCREPANCY

- FACIAL DEPTH
ANTERIOR-POSTERIOR DISCREPANCY

- FACIAL DEPTH
- MAXILLARY DEPTH
ANTERIOR-POSTERIOR DISCREPANCY

- FACIAL DEPTH
- MAXILLARY DEPTH
- CONVEXITY
Fig. 109: Convexity of Profile. A convex profile indicates a lower internal profile, a major number is a measure of convex internal profile.
LATERAL CEPHALOGRAM

- FACIAL PATTERN
- ANTERIOR POSTERIOR DISCREPANCY
- AIRWAY EVALUATION
### NORMS FOR AIRWAY MEASUREMENTS

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$\bar{x}$ – Mean  
$S$ – Standard Deviation
Orthodontic Radiographic Series for a Non-TMD Patient

• PANORAMIC RADIOGRAPH
• LATERAL CEPHALOGRAM
• POSTERIOR / ANTERIOR CEPHALOGRAM
POSTERIOR-ANTERIOR CEPHALOGRAM

• NASAL SEPTUM
• NASAL WIDTH
• MAXILLARY WIDTH
• INTERMOLAR WIDTH
• INTERCANINE WIDTH
POSTERIOR-ANTERIOR CEPHALOGRAM

• NASAL SEPTUM
POSTERIOR-ANTERIOR CEPHALOGRAM

- NASAL SEPTUM
- NASAL WIDTH
Fig. 159  Nasal Width
POSTERIOR-ANTERIOR CEPHALOGRAM

- NASAL SEPTUM
- NASAL WIDTH
- MAXILLARY WIDTH
Fig. 161  Maxillary Width
POSTERIOR-ANTERIOR CEPHALOGRAM

• NASAL SEPTUM
• NASAL WIDTH
• MAXILLARY WIDTH
• INTERMOLAR WIDTH
The Interdependence of the Nasal and Oral Capsules

Robert M. Ricketts, D.D.S., M.S.

Department of Orthodontics
Loma Linda University
DIAGNOSIS

• INITIAL EXAMINATION
• RADIOGRAPHIC AND CEPHALOMETRIC ANALYSIS
• MODEL ANALYSIS
MODEL ANALYSIS

- PALATAL WIDTH
- PALATAL MORPHOLOGY
- INTERMOLAR WIDTH
- INTERCANINE WIDTH
- ARCHLENGTH ANALYSIS
MODEL ANALYSIS

- PALATAL WIDTH
Figure 9. Ideal transpalatal width of the adult patient and mixed dentition patient. (Frontal cross-sectional view.)
Figure 10. Frontal cross-sectional view of patient with a constricted maxilla, as indicated by an intermolar width of 29 mm.
MODEL ANALYSIS

• PALATAL WIDTH
• PALATAL MORPHOLOGY
NAME: Brandon Saucier
DATE: 03-06-95
AGE: 9:6
NO.: 95-1228
MODEL ANALYSIS

- PALATAL WIDTH
- PALATAL MORPHOLOGY
- INTERMOLAR WIDTH
Orthodontic researchers and clinicians have traditionally considered the mandibular arch as the ultimate limitation for diagnosis, treatment planning, and therapy for nonextraction cases, ie, the size of the mandible and positions of the teeth could not assume dimensions that differed greatly from those of the malocclusion. These researchers simply confirmed what successors to Angle have presumed about expansion—that it remains unstable.

Orthodontists have habitually evaluated malocclusions as though they were an effect of mandibular development alone and that the maxilla should and could adapt around this somewhat immutable feature of the oral defect. Nevertheless, researchers have speculated that the maxilla should and could adapt around this somewhat immutable feature of the oral defect. Nevertheless, researchers have speculated that the maxilla should and could adapt around this somewhat immutable feature of the oral defect. Nevertheless, researchers have speculated that the maxilla should and could adapt around this somewhat immutable feature of the oral defect. Nevertheless, researchers have speculated that

The exploitation of this expansive capability offers orthodontists additional opportunities to accommodate crowded dentitions and to treat patients with a nonextraction regimen. Weinberg and Sadowsky explained how orthodontic clinicians have three options for increasing the arch perimeters of patients with crowded Class I relationships:

1. Distal retraction of molars
2. Advancement of incisors
3. Expansion of arches distal to the canines

Effective retraction of first molars requires the removal of second molars, and even this approach gains little space. The simple placement of brackets and archwires will ordinarily advance incisors, which will sometimes exceed acceptable positions. Of these 3 strategies, expansion distal to the canines probably offers the most benefits with the fewest liabilities. However, clinicians can avoid excessive incisor advancement by combining brackets and wires with a specially designed compressed titanium coil expander. The MSX 2000 appliance allows lateral arch development in the premolar and first molar regions, without subsequent incisor displacement (Fig 1).

The MSX 2000 Appliance

The MSX 2000 offers clinicians a low profile, continuous light-force fixed apparatus that mimics the expansion Frankel and others achieved with passive appliances. The MSX 2000 presents an assembly of tubes and rods soldered to either bands or crowns, and it receives its expansive energy from compressed titanium coil springs (Fig 2).

Clinicians can adapt the appliance for use in either the maxilla or mandible to achieve lateral arch development. Many orthodontists have trouble understanding the rationale for expansion in the maxilla in the absence of a crossbite. However, waiting until maxillary canines erupt with insufficient space offers a less desirable strategy than providing for their entrance while the patient undergoes growth and development.

Clinicians need to make a habit of evaluating the maxillary width, as measured between the 2 first permanent molars, to assess the need and potential for lateral arch development. It almost seems counterintuitive to view the maxillary arch as the limiting feature for the alignment of crowded mandibular incisors, but the maxillary expansion must accommodate the mandibular development.

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424 Courthouse Road
Gulfport, MS 39507, USA
www.gulfcoastorthodontics.com

A RATIONALE FOR EXPANSION
Michael Owen Williams, DDS
Larry W. White, DMD, MSD

TECH NOTES
Edited by: Larry W. White, DDS, MSD
(larrywwhite@hotmail.com)
Bishara suggests that a lingual arch in the mixed dentition will increase the potential for a terminal plane shift into a Class II malocclusion without distal retraction of the maxilla or the maxillary molars. When clinicians need maxillary molar retraction and expansion simultaneously, a variation of the MSX 2000 can achieve those aspects without benefit of an extraoral retractor (Fig 3).

Clinical Application
Providing extra arch perimeter represents a major feature of the MSX 2000, and this makes it valuable in treating borderline extractions patients. Profitt has suggested that 3 mm or less of arch-length discrepancy usually calls for nonextraction therapy. Ten millimeters or more of arch-length discrepancy almost certainly requires an extraction treatment plan. The patients with 4 to 9 mm of discrepancy represent a group that can justifiably receive either extraction or nonextraction therapy. A dependable arch development therapy can often achieve such treatment. The following treatment features an Asian female of 13 years 4 months with Class I molars and Class II canines (Figs 4 and 5). She had excessive overbite and overjet and considerable maxillary and mandibular arch-length discrepancies. A cephalometric evaluation revealed a midface deficiency anteroposteriorly and transversely (Fig 6). Therapy consisted of dual arch development with MSX 2000 appliances, in conjunction with a fully bonded 0.018-inch preadjusted appliance (Fig 7). The expansion devices continue until the maxilla expands to a minimum of 36 mm, as measured transpalatally from first molar to first molar at the lingual cementoenamel junction. The expansion occurred distal to the canines in both arches, along with improvements in facial dimensions (Figs 8 and 9).

As orthodontists diagnose and plan treatment for young patients, they need to anticipate what those adolescent faces may look like at maturity. By starting with the eventual end in mind, orthodontic clinicians can often select alternatives to extraction therapies for patients with nonprotrusive profiles.

Summary
Over the past 100 years, orthodontists have vacillated between extremes of nonextraction and extraction therapies. Injudicious selection of therapies despite facial dimensions has probably contributed to the major clinical disappointments within each style of therapy. The belief that expansion distal to the canines would not stabilize after the cessation of active treatment has contributed to the reluctance to use such therapy. However, experience has shown that this type of expansive, nonextraction therapy can have success without relapse and merits more attention from the specialty.
### Analysis (Ricketts)  

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<td>Lower lip E-plane (mm)</td>
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**Summary description**
- Facial types: Mesofacial, brachyfacial tendency (0.0)
- Skeletal: Class II tendency
- Dental: Class I
- Maxilla (anteroposterior): Mild retrusion
- Mandible (anteroposterior): Moderate retrusion
- Maxillary incisors: Normal
- Mandibular incisors: Normal
- Lower lip: Normal
- Overjet: 4.0 mm
- Overbite: 4.5 mm

[AU: WHAT DO ASTERISKS STAND FOR?]  

### Frontal analysis  

<table>
<thead>
<tr>
<th>Initial</th>
<th>Norm</th>
<th>Clinical deviation</th>
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<tbody>
<tr>
<td>Face width (mm)</td>
<td>133.0</td>
<td>134.6</td>
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<tr>
<td>Nasal width (mm)</td>
<td>32.8</td>
<td>30.4</td>
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<tr>
<td>Maxillary width (mm)</td>
<td>66.6</td>
<td>65.6</td>
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<tr>
<td>Mx-Md width right (mm)</td>
<td>13.6</td>
<td>11.0</td>
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<tr>
<td>Mx-Md width left (mm)</td>
<td>10.8</td>
<td>11.0</td>
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<tr>
<td>Molar relationship (right)</td>
<td>-0.2</td>
<td>1.5</td>
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<tr>
<td>Molar relationship (left)</td>
<td>-0.1</td>
<td>1.5</td>
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<tr>
<td>Interincisal width (mm)</td>
<td>52.7</td>
<td>57.0</td>
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<tr>
<td>Molar to jaw right (mm)</td>
<td>12.5</td>
<td>8.7</td>
</tr>
<tr>
<td>Molar to jaw left (mm)</td>
<td>11.2</td>
<td>8.7</td>
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<tr>
<td>Mandibular width (mm)</td>
<td>87.9</td>
<td>88.2</td>
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<td>Intercanine width (mm)</td>
<td>20.7</td>
<td>27.3</td>
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<td>Mx-Md midline (degrees)</td>
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<td>J distance right (mm)</td>
<td>32.5</td>
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<tr>
<td>J distance left (mm)</td>
<td>34.1</td>
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<tr>
<td>AG distance right (mm)</td>
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<td>AG distance left (mm)</td>
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<td>AG menton right (mm)</td>
<td>51.8</td>
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<tr>
<td>AG menton left (mm)</td>
<td>49.9</td>
<td>0.0</td>
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</table>

[AU: WHAT DO ASTERISKS STAND FOR?]  

**Fig 6** Pretreatment cephalometric tracing and analysis (Quick Ceph 2000)
Fig 7  Expansion views.

Fig 8  Posttreatment cephalometric tracings and superimpositions.
REFERENCES


Keys to Success

1. Diagnosis

2. Treatment Planning
TREATMENT PLANNING

- TREATMENT SEQUENCE
- APPLIANCE SELECTION
- TIMING OF APPLICATION
TREATMENT PLANNING

- TREATMENT SEQUENCE
TREATMENT PLANNING SEQUENCE

1. TRANSVERSE DIMENSION DEVELOPMENT
2. ANTERIOR-POSTERIOR ALIGNMENT
3. INTERDENTAL ALIGNMENT
CORRECT SEQUENCE

- ARCHFORM AND ARCHLENGTH DEVELOPMENT
- A-P CORRECTION
- ALIGNMENT AND OCCLUSION
1. TRANSVERSE DIMENSION DEVELOPMENT
   A. Maxillary
   B. Mandibular

2. ANTERIOR-POSTERIOR ALIGNMENT

3. INTERDENTAL ALIGNMENT
CORRECT SEQUENCE

• ARCHFORM AND ARCHLENGTH DEVELOPMENT
EARLY DEVELOPMENT OF MAXILLA

- MIDFACE DEVELOPMENT
EARLY DEVELOPMENT OF MAXILLA

• MIDFACE DEVELOPMENT
• NASAL RESPIRATION
“Treating malocclusions with appliances
Which expand the maxillary arch
Can also reduce nasal stenosis.”
EARLY DEVELOPMENT OF MAXILLA

- MIDFACE DEVELOPMENT
- NASAL RESPIRATION
- MANDIBULAR POSTURE
Fig. 154  Maxillomandibular Midline
MANDIBULAR GROWTH
Mandibular Growth:

“There is no genetic predetermination of the final length of the mandible.”

Andre Petrovic

AAO annual meeting
Philadelphia 1997
Expansion Herbst
Cemented 5-12-93

Lower Herbst
Removed 8-27-93

Upper Herbst
Removed 12-19-95

MAX 2000
12-19-95 to 3-24-97

Full bond 1-19-96
EARLY DEVELOPMENT OF MAXILLA

• MIDFACE DEVELOPMENT
• NASAL RESPIRATION
• MANDIBULAR POSTURE
• PERIODONTAL HEALTH
Periodontal Health

“Diagnosis and Treatment of The Transverse Dimension”

Robert L. Vanarsdall, Jr., D.D.S.

96th Annual Session

AAO

Denver, Colorado
May 11-15 1996
Wolf’s Law Expanded

“Bone elements place or displace themselves in the direction of functional pressure”
“...shifting a bone to a new position in the muscle system results in reorganization of shape and structure...”
Typical Treatment Decisions

Juvenile and Early Adolescent Orthodontic vs. Orthopedic
Orthopedics: Change in

1. Direction
2. Magnitude
3. Morphology

of Osseous Tissue Formation
Palatal Expansion

Orthopedic Intermittent Force vs Orthodontic Continuous Force
TREATMENT PLAN SEQUENCE

1. TRANSVERSE DIMENSION DEVELOPMENT
   A. Maxillary
   B. Mandibular

2. ANTERIOR-POSTERIOR ALIGNMENT

3. INTERDENTAL ALIGNMENT
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- ARCHFORM AND ARCHLENGTH DEVELOPMENT
- A-P CORRECTION
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2. ANTERIOR-POSTERIOR ALIGNMENT
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- A-P CORRECTION
- ALIGNMENT AND OCCLUSION
TREATMENT PLAN SEQUENCE

1. TRANSVERSE DIMENSION DEVELOPMENT
2. ANTERIOR-POTERIOR ALIGNMENT
3. INTERDENTAL ALIGNMENT
CLASS I CROWDED

EXPANSION VS EXTRACTION
Extraction Vs. Expansion

“An Examination of Dental Crowding and its Relationship to Tooth Size and Arch Dimension”

Howe, Raymond P., McNamara, James A., And O’Connor, Amer. Jour. of Orthodontics
RAPID PALATAL EXPANSION

- ADVANTAGES
- DISADVANTAGES
RAPID PALATAL EXPANSION

vs.

PHYSIOLOGICAL DEVELOPMENT

- RESULTS
- STABILITY
Major Scientific Breakthrough in Orthodontics!

New standard in Dentofacial Orthopedics is Proven

"From our evidence-based clinical studies, it seems that Dr. Williams does not merely move teeth, he sculpts faces by harnessing natural bone growth and directing its trajectory toward full natural epigenetic development."

— Neal C. Murphy, DDS, MS, Associate Clinical Professor, Case Western Reserve University, School of Dental Medicine
Visiting Lecturer, UCLA School of Dentistry • Founder, UCLA Orthodontic Study Club

"Osteoblast Recruitment"

Patient E. R. Expansion achieved with Max-2000®. No activations required. See adjacent histological findings for this patient.

Histological section of bone from buccal alveolus cortex at the coronal third of the root (near the CEJ) documenting the effects of a Series 2000® expansion appliance.

Same microscopic section as Fig 1 under polarized light demonstrating a "woven" immature bone pattern.

"...pattern consistent with woven bone (new bone)...."

— Dr. Russell Christianson, Professor of Oral and Maxillofacial Pathology, UCLA School of Dentistry
“Slow Maxillary Expansion with Nickel Titanium”

Robert Marzban, DDS
Ravinda Nanda, BDS, MDS, m PHD

Journal of Clinical Orthodontics
August 1999
RAPID PALATAL EXPANSION

vs.

PHYSIOLOGICAL DEVELOPMENT

• RESULTS
Phase I Treatment
Haas Maxillary Expander
1-14-94 to 11-14-94

Neutral Bionator
12-5-94 to 2-5-96

Fr II
2-5-96 to 10-22-96
<table>
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<td>11/12/93</td>
<td>10mo</td>
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<tr>
<td>Gr 3.0</td>
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</tr>
</tbody>
</table>
Wolf’s Law

“The shape and structure of a bone depends on the stress placed upon the bone by the musculature.”
Wolf’s Law Expanded

“Bone elements place or displace themselves in the direction of functional pressure.”
“Changing muscle activity will affect bone morphology...”

applies to the use of functional appliances
“The Influence of Functional Appliance Therapy on Glenoid Fossa Remodeling”

Donald G. Woodside
A. Metaxas, and G. Altuna

AJO VOL. 97  Sept. 1987
“We now know how Functional Appliances work, it’s the glenoid fossa that changes.”

Dr. Tom Graber

New-Conn Orthodontic Growth Symposium
White Plains, New York
April 10 -11, 1997
Craniofacial Complex Components Affecting Mandibular Growth

1. Cranial Base
2. Glenoid Fossa
3. Nasomaxillary Process
4. Dental alveolar Process
“Every Problem Has a Solution: Simple and Wrong”

H. L. Menken
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with Dr. Michael Williams

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The Woodlands Waterway Marriott

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