ORTHODONTICS IN THE LIGHT OF NUTRITIONAL AND HORMONAL DEFICITS

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ABSTRACT

Nutrition and hormonal balance are the building blocks of craniofacial growth, dental development, and orthodontic treatment success. Early visionaries such as Guilford emphasized the key role of nutrition in the prevention of malocclusions and dentofacial anomalies. Malnutrition, whether from inadequate dietary intake or compromised nutrient absorption, can negatively impact bone development, immune function, and masticatory efficiency, particularly during adolescence when physiological needs are increased. Key macronutrients like carbohydrates and proteins influence jaw growth and muscle development, while refined diets lacking fibrous content are linked to increased malocclusion rates, such as Class II Division 1.

Minerals and vitamins are needed for enamel development, periodontal disease, and tooth eruption. Vitamin deficiencies in A, C, D, and the B-complex can cause retardation of dental development, impaired tissue healing, and reduced orthodontic results. Calcium, phosphorus, and magnesium are minerals that play significant parts in bone density and mineralization of teeth.

Hormones such as growth hormone, thyroid hormones, parathyroid hormone, estrogens, and corticosteroids control bone remodeling and orthodontic tooth movement. Hormonal disturbances can modify treatment response, influence craniofacial symmetry, and affect the speed of tooth movement.

A well-planned diet that is specific to the orthodontic patient is essential for a successful outcome. Nutritional counselling must be included in orthodontic treatment in order to target frequent deficiencies and enhance healing and stability. A final understanding, therefore, by all disciplines involved of the complex interaction between diet, hormones, and orthodontics guarantees ideal patient results, especially during crucial periods of development. This wide-ranging approach encourages not only alignment of the teeth but also overall facial harmony and systemic well-being.

KEYWORDS: Malnutrition, Hormonal Disorders, Orthodontics, Nutrients, Vitamin Deficiency

1. Introduction

Early visionaries such as Guilford emphasized the importance of nutrition in craniofacial growth and associated dietary deficiencies with dentofacial deformities and malocclusions. Nutrition and hormonal balance are central to overall health, facial harmony, dental proportion, and overall craniofacial development. A balanced diet has a beneficial impact on periodontal health, oral flora, immune function, and masticatory efficiency—factors of prime importance in orthodontic treatment planning.

Orthodontic treatment itself may influence dietary intake and nutritional needs, particularly at puberty when physical and emotional stresses increase nutritional demands. Singh and Chawla (1994) investigated the North Indian population and revealed that occasional or no use of coarse, fibrous food was significantly related to a higher frequency of Class II Division 1 and skeletal malocclusions.

Waugh, Klatsky, and Fisher reported a direct correlation between decreased chewing power and immature muscles of mastication, with resulting enhanced risk of malocclusion. A soft diet does not give proper masticatory stimulus, with resulting smaller maxillary arches and the cause of conditions such as 'Arch collapse syndrome'.1

2. Nutrition and Orthodontic Health

As stated by the American Medical Association's Council of food and nutrition.

Nutrition is "The science of food, the nutrients and other foods substances contained therein, their action, interaction and balance in relation to health and disease and the processes by which the organism ingests, digests, absorbs, transports, utilizes, and excretes food substances.".

Malnutrition: is a disorder that can be caused by incorrect or insufficient food consumption or by defective absorption of nutrients, is stress- and disease-modulated, and can be acute or chronic and reversible or irreversible.

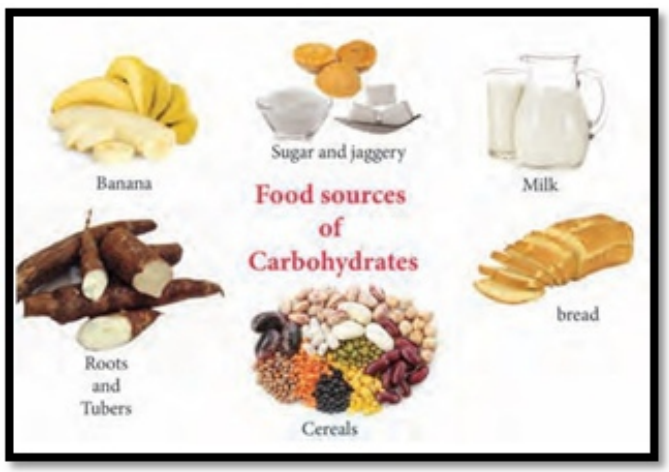
Good nutrition is critical to sustaining general health, ensuring normal growth, and averting systemic and oral diseases. It is imperative that both general health professionals and specialists such as orthodontists have a complete grasp of nutritional science2

Essential Nutrients	Non-Essential Nutrients
Carbohydrates	Cellulose
Proteins	Hemicellulose
Fats	Pectins
Vitamins	
Minerals	
water	

➢ **Carbohydrates**

Carbohydrates are the sugar molecules acting as a principal source of body energy. Carbohydrates would ideally provide a quarter of total energy needs, and typical sources in the diet are cereals like chapattis, rice, and bread. These food items are everyday staples of Indian cuisine and, particularly, orthodontic appliances are convenient when one is undertaking orthodontics, since many grain foods tend to be soft and easy to chew. For braces wearers who feel uncomfortable, mashing and dunking chapattis in dal or curry can facilitate continued ingestion of essential macronutrients—carbohydrates and proteins.

Yet, more recent dietary habits have demonstrated considerable increase in intake of refined carbohydrate foods and soft processed foods with the consequent severe implications for craniofacial growth. These diets are less masticatorially demanding and thus reduce the size of the jaw, give rise to constricted maxillary arches, and to less developed masticatory muscles. The absence of coarse fibrous foods is inadequate to elicit normal muscle function, necessary for normal bone and dental arch development.3



Other effects of excess refined carbohydrate consumption are:

- timing of tooth eruption
- Short mandibles and slender condyles
- Diminished tonicity of temporalis and masseter muscles
- Decreased skull's linear dimension
- Higher frequency of malocclusions

These alterations in craniofacial architecture tend to cause crowding, impactions, and ectopic eruptions as a result of inadequate space for tooth eruption.

Balanced carbohydrate intake, especially from coarse and fibrous food, is not only necessary for energy but also to encourage correct development of the jaw and oral health. In orthodontic patients, awareness of the quality and texture of carbohydrates being consumed can make a significant impact on the treatment success and stability in the long run.

➢ **Proteins**

Proteins are essential macromolecules required for growth, repair, and body structural development, including craniofacial structures. Protein deficiency—particularly during the developmental years—may result in severe dentofacial deformities. Protein malnutrition is linked with:

- Shortened mandibles
- Decreased jaw height
- Delayed eruption of teeth
- Decreased skull base length
- Narrow maxillary and mandibular widths
- Decreased lower facial height

Diseases like marasmus and kwashiorkor are instances of protein-energy malnutrition that affect craniofacial development, cause delays in developmental milestones, and lead to dental anomalies.

There is an essential interaction between maternal-fetal nutrition and craniofacial growth. Pregnancy is a time when

the placenta provides vital protein substrates, and fetal tissue uses them to produce proteins and nucleic acids. Alterations in substrate supply at this time result in reduced protein metabolic potential, distorting normal development. According to Miller, "critical periods" of organ growth are present—stress or diet deficiency of any type that occurs during these periods can cause irreversible structural alterations.

From a clinical and practical orthodontic view, protein consumption also needs to be adjusted to the patient's condition. For people with braces:

- Meat, although a nutritious protein source, tends to be hard to chew because it is fibrous.
- Eating meat straight off the bone is not recommended.
- Orthodontic patients should eat tender and lean cuts of meat sliced into small, bite-sized pieces.

• Soft protein-containing alternatives such as cottage cheese

and tofu are less difficult to chew and yet maintain protein needs.

Protein intake is vital for regular craniofacial development and stability of orthodontic treatment. Knowledge of protein's role both in growth and dietary habit in treatment prevents lifelong dentofacial problems and helps achieve the best treatment results.4

➢ **Fats**

Lipid metabolism disturbances are relatively rare, but when they happen, they have a strong impact on craniofacial development and overall health. Certain characteristic disorders are:

• Gaucher's disease
• Niemann–Pick disease

These disorders are linked to wider systemic threats such as:

• Type II Diabetes
• Congestive heart failure
• Hypertension
• Coronary artery disease
• Arrhythmias
• Obstructive sleep apnea

While these are rare in teenagers, their greater prevalence in adult orthodontic patients makes them important to recognize. In adult patients, mandibular advancement splints frequently treat sleep apnoea.

Leptin and Craniofacial Development

Leptin, a hormone secreted by adipocytes (fat cells), plays a key role in fat regulation through feedback mechanisms and is implicated in bone and craniofacial development.

• Yagasaki et al. performed mouse experiments to test the role of leptin in craniofacial development. Leptin deficiency in mice resulted in:

o Lower mandibular measurements: Go-Pg, Co-Gn, Co-Pg, and Go-Me
o These measurements normalized following leptin supplementation
o Interestingly, mandibular width and long bone width increased with leptin administration

Ohrn et al. have suggested that short upper facial heights can be caused by reduced levels of growth hormone, which is downregulated in obesity. This illustrates how disturbances in lipid metabolism and nutritional deficiencies can influence endocrine gland functioning—ultimately impacting facial development and dentition.5

Milk and Milk Products

Milk and its derivatives play a crucial role in craniofacial and dental development. They are rich in:

- Calcium – important for bone and tooth mineralization
- Vitamin D – aids calcium absorption
- Potassium – maintains fluid balance and muscle function
- Protein – supports tissue repair and bone matrix formation

➢ **Vitamins**

According to WHO:

- Vitamins are essential organic compounds required in small amounts for normal growth, metabolism, and overall health.
- Optimal levels of vitamins during critical growth periods are crucial for skeletal and dental development.

Fat-Soluble Vitamins	Water-Soluble Vitamins
Vitamin A	Vitamin C
Vitamin D	All B Vitamins
Vitamin E	
Vitamin K	

Vitamin A

- Essential for epithelial integrity
- Promotes proper bone and tooth formation
- Deficiency may lead to:
  - o Keratinizing metaplasia
  - o Increased vulnerability to infection

Vitamin C (Ascorbic Acid)

- Crucial for collagen synthesis
- Impacts:
  - o Periodontal ligament (PDL) integrity
  - o Osteoid formation
  - o Tooth movement and post-orthodontic retention
- Deficiency may cause:
  - o Impaired orthodontic response
  - o Higher relapse rates after treatment

Vitamin D

- Regulates calcium and phosphorus metabolism
- Supports:
  - o Bone and tooth mineralization
  - o Overall skeletal growth
- Deficiency consequences:
  - o Rickets
  - o Maxillary dysplasia
  - o Cranial softening
  - o Cleft lip and palate susceptibility
  - o Delayed facial suture closure
  - o Malocclusions (e.g., open bite, transverse hypodimension, high-arched palate)

Vitamin B Complex

- Deficiency may result in:
  - o Glossitis
  - o Gingivitis
  - o Angular cheilitis
  - o Oral mucositis

Folic Acid

- Deficiency may lead to:
  - o Non-inflammatory necrosis of gingiva
  - o Periodontal ligament and alveolar bone damage

➢ **Minerals**

Calcium, phosphorus, and magnesium are critical in enamel and bone mineralization. Imbalances may lead to delayed dental development and compromised tooth structure.

- Calcium, Phosphorus, and Magnesium are critical for enamel and bone mineralization.
- Even trace deficiencies can profoundly affect dentofacial development.
- Magnesium deficiency has been linked to bruxism (teeth grinding).
- Calcium and phosphorus must be present during tooth calcification periods to ensure optimal development.6

Categories of Minerals

Principle Elements (60–80% of body's inorganic	Essential Trace Elements	Possibly Essential Trace Elements	Non-Essential Trace Elements
Calcium	Iron	Nickel	Aluminium
Phosphorus	Copper	Vanadium	Lead
Magnesium	Iodine	Cadmium	Mercury
Sodium	Manganese	Barium	Boron
Potassium	Zinc		Silver
Chloride	Molybdenum		Bismuth
Sulphur	Cobalt, Fluorine, Selenium, Chromium		

Clinical Note

- Deficiencies during childhood and adolescence can impair:
  - Jaw development
  - Tooth eruption
  - Condylar growth
  - Facial symmetry and aesthetics
- Nutritional management is key in orthodontic and pediatric dental care.

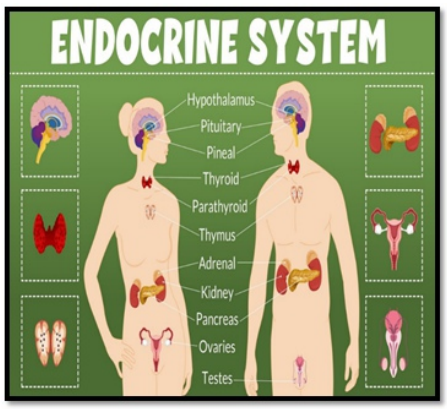
➢ **Water**

It plays a vital role in maintaining physiological balance by transporting nutrients and waste products and participating in a wide range of chemical reactions within the body. An average person requires 2–3 litres of water per day to maintain optimal hydration.

Dehydration can significantly affect oral health, leading to dry mouth (xerostomia), bad breath (halitosis), and an increased risk of dental caries due to reduced salivary flow. These issues are especially concerning in individuals wearing orthodontic appliances, as proper hydration is essential to maintain oral comfort, hygiene, and appliance function.

3. Hormones

The nervous and endocrine systems are intricately connected—many nervous system functions are executed by hormones, and endocrine functions are under neural control. Hormones significantly affect growth, skeletal development, and the biological processes involved in orthodontic tooth movement. Systemic hormonal imbalances or therapeutic hormonal interventions can alter orthodontic outcomes.[7]



➢ **Growth Hormone (GH)8**

- Source: Secreted by acidophils of the anterior pituitary.
- Mechanism: Acts indirectly on bone via somatomedin (from the liver).
- Craniofacial Effects:
  - GH deficiency → reduced mandibular length, small ramus height (Condylion–Gonion), shorter facial height, retrognathic maxilla.
  - Posterior cranial base smaller than anterior (N-S).
  - Face retains childlike convexity.
- **Dental Development:**
  - Dental development (tooth eruption, root resorption) delayed proportionally with skeletal development.
  - Minimal influence on primary teeth; more effect after 9 months of age.
- **GH Therapy:**
  - Enhances condylar growth, increases anterior and posterior facial height, especially Gnathion–Condylion length.

- Limited impact on cranial base.

➢ **Thyroid Hormones (T3, T4 / Thyroxin)9**

Function: Regulate metabolism and bone remodelling.

Craniofacial Effects:

- Hypothyroidism: Delays craniofacial growth, reduces facial height and bone density, impairs eruption.
- Cranial vault shows growth retardation in children with untreated hypothyroidism.

Orthodontic Relevance:

- Thyroxin therapy stimulates bone resorption via increased prostaglandin synthesis.
- Enhances bone remodelling and speeds up tooth movement.

➢ **Parathyroid Hormone (PTH)7**

Function: Regulates calcium-phosphorus homeostasis.

Effects:

- Continuous PTH → Catabolic: ⊠ osteoclast activity → bone resorption.
- Intermittent PTH → Anabolic: ⊠ osteoblast activity → bone formation, bone remodelling.

Orthodontic Application:

- Stimulates turnover of bone, facilitating tooth movement.
- Releases osteogenic growth factors, enhancing remodeling.

➢ **Estrogens and Sex Hormones**

Forms: Estradiol, Estrone, Estriol.

Functions:

- Regulate bone and collagen metabolism.
- ↑Osteoblast activity, ⊠ osteoclast activity.
- Inhibit pro-resorptive cytokines (TNF, IL-1, IL-6).

- **Effects on Orthodontics:**
  - ↓Rate of tooth movement (slows bone resorption).
  - Estrogen deficiency → faster movement.
  - Hormonal contraceptives affect treatment timing.
  - Tooth movement varies with menstrual cycle:
    - Faster during menstruation (low estrogen).
    - Slower during ovulation (high estrogen).
- **Cellular Influence:**
  - Enhances alkaline phosphatase (ALP) activity, osteocalcin (OCN), and osteoprotegerin (OPG) in periodontal ligament cells (PDLCs).
  - Modulates collagen fibre deposition and cross-linking.

➢ **Androgens**

Function: Modulate muscle growth and bone metabolism.

Effects:

- Inhibit bone resorption.
- Can influence duration and outcome of orthodontic treatment.7

➢ **Corticosteroids**

Function: Anti-inflammatory, immunosuppressive.

Effects:

- Inhibit osteoblast function → reduced bone formation.
- Increase rate of tooth movement.
- Decrease post-treatment stability due to compromised bone regeneration.

Clinical Implication: May reduce anchorage stability during orthodontics.7

➢ **Prostaglandins (PGE1, PGE2)**

Source: Synthesized in response to orthodontic forces.

Function: Stimulate osteoclastic bone resorption.

Studies:

- Yamasaki et al: Orthodontic force induces endogenous prostaglandin production.
- Lee et al: Systemic PGE1 more effective than local for bone resorption.

Mediators: PGE2 effects amplified by growth factors (PDGF), interleukins, and PTH.

Clinical Use:

- Topical/systemic administration can enhance tooth movement.
- Drawbacks: Pain, rapid metabolism → frequent dosing required.

➢ **Calcitonin**

Function: Opposes PTH; inhibits osteoclasts → reduces bone resorption.

Orthodontic Impact:

- Slows down tooth movement.
- Stimulates osteoblast activity → promotes bone formation.

Other Functions:

- Decreases ruffled borders of osteoclasts (essential for resorption).
- Works with Vitamin D3 and PTH in calcium and phosphate homeostasis.

➢ **Vitamin D3 (Calcitriol)**

Function: Enhances calcium and phosphate absorption.
Bone Effects:
- o Increases bone mass and mineral density.
- o Used clinically in osteoporosis.

Orthodontic Impact:
- o Inhibits orthodontic tooth movement (indirect effect).
- o May delay treatment progression.7

Summary Table: Hormonal Influence on Tooth Movement

Hormone	Effect on Tooth Movement	Mechanism
Growth Hormone	Accelerates with therapy	Enhances condylar growth, facial height
Thyroid Hormones	Accelerates	↑ Bone turnover via prostaglandins
Parathyroid Hormone	Accelerates (intermittent)	↑ Osteoclast/osteoblast activity
Estrogens	Inhibits	↓ Bone resorption, ↑ osteoblast activity
Androgens	May modulate (inhibits resorption)	Influences muscular and skeletal system
Corticosteroids	Accelerates	↓ Bone formation, ↑ resorption
Prostaglandins	Accelerates	Direct stimulation of osteoclasts
Calcitonin	Inhibits	↓ Osteoclast activity, ↑ Osteoblast stimulation
Vitamin D3	Inhibits	↑ Bone mass, ↓ Resorption

4. Orthodontic Treatment and Balanced Diet

Nutrition is a crucial factor in orthodontic treatment success. A balanced diet assists in tissue response, bone remodelling, and overall patient health, especially during the physiologically challenging adolescent years.

Importance of Diet History
- A comprehensive dietary history must be recorded prior to initiating orthodontic treatment.
- It assists the orthodontist in directing the patient based on their food habits, preferences, and limitations.
- Patients are instructed to adopt a "Stop, Halt, and Go" eating regimen throughout treatment for minimal complications and maximum effective outcomes.[10]

Nutritional Needs Throughout Orthodontic Treatment
- o Application of orthodontic force induces stress in bones and periodontal ligaments, necessitating:
- o Sufficient protein to repair and remodel.
- o Healthy bone turnover requiring adequate vitamins and minerals.
- o Teenagers—the average age group—possess great nutritional needs but poor diet.
- o External circumstances such as emotional stress, use of drugs (e.g., alcohol, phenytoin), or oral contraceptives can further enhance nutritional needs.

Role of Key Nutrients

Nutrient/Food Group	Function/Orthodontic Relevance
Dairy (milk, cheese, ice cream)	Soft, easy to chew, rich in calcium and vitamin D for bone health.
Fruits and Vegetables	Provide vitamins (like C, A, beta-carotene) and fibre. Should be cut into small pieces.
Citrus fruits (e.g., oranges, berries)	High in Vitamin C; recommended 3–4 days after wire change to reduce discomfort.
Nuts and seeds	Hard and small – difficult to chew with braces; choose nut butters or ground forms instead.
Tofu and cottage cheese	Good meat alternatives for protein; soft texture makes them braces-friendly.
Meat (boneless, small pieces)	Avoid fibrous parts and bones; soft meat only.
Whole grains (bread, rice, pasta)	Provide energy and essential nutrients.
Chromium & Beta Carotene	Often found to be low in orthodontic patients – important for glucose metabolism and antioxidant defense.

5.Common Dietary Imbalances in Orthodontic Patients

Studies have shown orthodontic patients often exhibit:

- Higher intake of saturated and unsaturated fats, cholesterol.
- Lower intake of:
  - Dietary fibre
  - Chromium
  - Beta-carotene

These imbalances can impair tissue healing, delay bone remodelling, and affect treatment outcomes.11

➢ **Dietary Counselling and Education**

- Dietary counselling is essential and should be an ongoing part of orthodontic care.
- Educational techniques:
  - Teach patients to maintain a 3–5-day dietary log.
  - Evaluate nutrient balance and food group representation.
- Dental education mandates:
  - ADA guidelines require dental graduates to be competent in providing dietary counselling related to oral health.
  - Nutrition is a core subject in Indian dental curricula.

➢ **Food Groups for a Balanced Diet**

1. Vegetables
2. Fruits
3. Milk, yogurt, and cheese
4. Protein sources: Meat, poultry, fish, dry beans, tofu, eggs, nuts (in soft form)
5. Carbohydrates: Bread, cereals, rice, pasta

Each group contributes uniquely and cannot substitute for one another.

➢ Braces-Friendly Eating Tips

Foods to Eat (Soft, Non-Sticky, Easy to Chew)

- Banana
- Biriyani
- Cake
- Boneless meat (soft, cut into small pieces)
- Orange
- Chapatti
- Burger (soft bun)
- Pulses
- Litchi
- Eggs
- Ice cream (without nuts)
- Fish (boneless)
- Vegetable pulao
- Puri
- Bread

✕ Foods to Avoid (Hard, Sticky, or Chewy)

- Banana chips
- Bhelpuri
- Carrot (raw)
- Chips
- Chewing gum
- Chocolate (sticky types)
- Cold drinks
- Dry fruits
- Guava (especially seeds)
- Meat with bone
- Pizza (hard crust)
- Popcorn
- Ice cream with nuts
- Pan masala
- Halwa
- Sticky snacks

1. CONCLUSION

Nutrition and endocrine balance are crucial to craniofacial growth, dental development, and successful orthodontic treatment. Insufficiencies in critical nutrients—like proteins, vitamins (A, C, D, B-complex), minerals (calcium, phosphorus, magnesium), and water—can cause severe disruption to jaw growth, tooth eruption, and bone metabolism. Similarly, hormonal imbalance involving growth hormone, thyroid hormones, estrogens, and corticosteroids can affect bone remodelling and orthodontic tooth movement. Contemporary eating habits with soft, processed food led to diminished masticatory function and play a role in the development of malocclusions. The patient's diet needs to be monitored and controlled while receiving orthodontic treatment carefully in order to provide higher physiological requirements, particularly during adolescence. Dietary guidance, education on well-balanced diet, and appreciation of endocrine interactions offer an overall strategy to enhance orthodontic treatment and ensure long-term stability of results.10

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