Dear CDSHK Fellows in Orthodontics,

I am pleased to announce that the 'Orthodontic Biomechanics Series 2024-2025', a free CME course, has already launched. It first debuted during the COVID-19 pandemic. For this second iteration, the content has been updated, and the lectures have been recorded and uploaded to the HKAM LMS Canvas system. Each lecture is divided into video clips of less than 25 minutes. A total of 14 lectures are planned, with the first two having been launched on September 1, 2024. The remaining lectures will be launched at the beginning of each subsequent month, with two lectures being released simultaneously.

Additionally, a CME quiz with 5 multiple-choice questions per lecture will be included. A passing score of 60% (3 out of 5 correct answers) will grant CME points. CME accreditation will be applied for and is subject to approval.

If you are interested in this course, please enroll by filling in the following Google Form: https://forms.gle/Z5ArgcstffXBPhtF9

SUMMARY OF CURRICULUM VITAE OF DR. SHE TSANG TSANG

Dr. SHE Tsang Tsang, Franklin 佘崢崢

Specialist in Orthodontics in Hong Kong, China

BDS (Hons) (HK) 1998, M Orth (HK) 2002, M Orth RCS (Edin) 2003
AdvDip (Ortho) (HK) 2004, FCDSHK (Ortho) 2005, FHKAM (Dental Surgery) 2005, FDSRCS (Edin) 2013

- Over 20 years of experience in exclusive orthodontic private practice
- Part-time Clinical Lecturer, Postgraduate Orthodontic Program, The University of Hong Kong (HKU)
  - Lectures series (30 hours) and workshops (25 hours) on Orthodontic biomechanics, segmented arch technique, skeletal anchorage and face-driven treatment planning
  - Co-chairman of the Perio-Ortho joint consultation clinic
- Publications:
  - Book chapter on 3D occlusograms
  - Book translation to Chinese on Orthodontic Biomechanics
  - Articles in American Journal of Orthodontics and Dentofacial Orthopedics, Journal of Dental Research
- Award:
  - Fu Minkui APOS Tends Award for the Best Clinical Article 2017-2018
- International speaker:
  - World Implant Orthodontic Conference (WIOC) 2017
  - World Orthodontic Biomechanics Symposium 2019, 2023
  - Asian Pacific Orthodontic Conference (APOC) 2020
  - EFP International Perio Master Clinic (Perio-Ortho Synergy) 2024
- Examiner:
  - Conjoint examination of Membership in Orthodontics, Royal College of Surgeons of Edinburgh and College of Dental Surgeons of Hong Kong (CDSHK)
  - Intermediate and Exit examinations, Orthodontic Specialty, CDSHK
- Current position:
  - Chairman of the Orthodontic Specialty Board, CDSHK

Orthodontic Biomechanics Series 2024-2025

Title: Lecture 1 - Introduction to the Orthodontic Biomechanics Lecture Series

The opening lecture of this series explores the lecturer's educational journey in orthodontic biomechanics, highlighting key textbooks and outlining the curriculum. The session will proceed with an analysis of a case study where conventional straight-wire mechanics failed and the subsequent successful management by using the segmented arch technique and miniscrew anchorage. This case study will lead to the introduction to the 'Guideline for Leveling and Alignment' which provides an algorithm to plan difficult tooth movements and avoid complications. Subsequently, foundational biomechanical concepts will be introduced, such as:

- The distinction between force and force system (force and moment)
- Line of action and point of force application.
- Moment of force and moment of couple.
- Equivalent force systems.
- The differentiation between the center of mass and the center of resistance.
- The analysis of one-couple, two-couple, and multiple-couple force systems in orthodontic appliances.
- Difference between statically determinate and indeterminate force systems.

The biomechanics of molar uprighting with extrusion will be contrasted between straight wire mechanics and cantilever systems, setting the stage for a discussion on the simultaneous intrusion or mesialization during molar uprighting as the conclusion

This lecture will be delivered through the learning management system of HKAM.

The CME quiz is available for fellows and higher trainees.

Following Lecture 1 and 2, there will be a physical 3-hour hands-on session dedicated to discussing and consolidating the information covered during the lectures for MOrth students.

Orthodontic Biomechanics Series 2024-2035

Lecture 2: Characteristics of Force Systems and Equivalency

The lecture is set to begin with a review and detailed discussion of the characteristics of force systems. The concept of equivalency will be elaborated upon, with the introduction of the equivalency equation:

$\sum F1 = \sum F2, \sum M1^* = \sum M2^*$ (* in any arbitrary point)

The significance of this equation for the comprehension of tooth movement induced by the force system of an orthodontic appliance will be examined. Additionally, the diagram method, a more clinically relevant approach for solving problems of equivalence, will be introduced and supported by mathematical proofs. The practical application of equivalency in the design of orthodontic appliances will be explained through a series of case studies, with the revisit of the guidelines for leveling and alignment.

The session will be concluded by introducing the first exercise question for the participants to consolidate the mathematical concept of equivalency and introduce the addition of non-concurrent force systems, which will be discussed in the next lecture.

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Orthodontic Biomechanics Series 2024-2025

Lecture 3: Multiple Lines of Action and Addition of Force Systems

This session will explore why it is necessary to apply different force systems, with varied lines of action, to a single body either simultaneously or at separate times. The concepts of concurrent and non-concurrent force systems will be clarified. The methods for combining concurrent forces—using parallelogram, polygon, and analytical techniques—will be reviewed, with a refresher in trigonometry included. For non-concurrent forces, summation of forces by using the equivalency equation and free body diagrams will be demonstrated. A practical exercise will be included to reinforce the concept of adding non-concurrent force systems to control the occlusal plane inclination during whole arch intrusion. Two orthodontic cases for the treatment of patients with Temporomandibular Disorders (TMD) will be discussed, with additional focus on:

1. The importance of interdisciplinary management of complex cases: Severe TMD should be treated before definitive orthodontic treatment planning, as occlusion changes after splint therapy.
2. Factors to consider in face-driven diagnosis and treatment planning.

This lecture will be delivered through the learning management system of HKAM.

The CME quiz is available for fellows and higher trainees.

Following Lecture 3 and 4, there will be a physical 3-hour hands-on session dedicated to discussing and consolidating the information covered during the lectures for MOrth students.

Orthodontic Biomechanics Series 2024-2025

Lecture 4: Newton's First and Third Laws and Their Relevance to Appliance Design

This lecture will explore the concept of equilibrium, as described by Newton's First Law, and its relevance to activation force systems of orthodontic appliances. We will discuss the equations $\sum F=0$ and $\sum M^*=0$ (* at any arbitrary point), which signify that the sum of forces and moments equals zero, indicative of a state of equilibrium. Additionally, we will investigate the relationship between activation and deactivation force systems, as explained by Newton's Third Law, and their application to the mechanics of orthodontic treatments.

Working through exercises, we will analyze a series of clinical scenarios, including molar intrusion via dental and skeletal anchorage, molar mesialization and distalization using direct and indirect skeletal anchorage, and techniques such as sliding jigs, lace-backs, and the Eastman method. Participants will learn to use the principle that 'all forces and moments sum to zero' as an effective tool for understanding the clinical effects of these commonly used orthodontic devices.

Further examination of cantilevers, with an understanding of Newton's First and Third Laws, will allow us to clarify the activation and deactivation force systems associated with these devices. We will distinguish between equilibrium and equivalency using mathematical proofs, aiming to prevent conceptual misunderstandings when analyzing the force systems of cantilevers and the teeth to which they are connected.

The discussion will proceed addressing the various configurations of cantilevers, such as minor and major, their different connections, and the resulting force systems. We will introduce a standardized, step-by-step procedure for activating cantilevers of any shape in two dimensions.

In conclusion, we will relate the length of a cantilever to its third-order side effects and the moment-to-force ratio (M/F) of tooth movement, paving the way for our forthcoming topic: the mechanics of tooth movement.

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The CME quiz is available for fellows and higher trainees.

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Orthodontic Biomechanics Series 2024-2025

Lecture 5: Mechanics of Tooth Movement

The lecture will delve into the mechanics of tooth movement, focusing on the critical relationship between the moment-to-force ratio (M/F ratio) at the Center of Resistance (CRes) and the distance between the Center of Rotation (CRot) and the CRes. A graphical presentation will illustrate how variations in M/F ratio at the CRes dictate different forms of tooth movement, such as pure rotation, pure translation, and combined movements.

The discussion will extend to explain that the variation of M/F ratio at the bracket level create different tooth movements, including uncontrolled tipping, controlled tipping, translation, and root torque. The clinical significance of the M/F ratio in relation to the CRot position will be analysed, emphasizing its importance in the design of orthodontic appliances.

Additionally, the lecture will explore the use of geometric construction techniques to determine the location of the CRot of tooth movement and determine the line of action of the single force to produce the planned movement. A case presentation will illustrate this process, including a detailed explanation of how to identify the line of action of a single force, customize appliance design and monitor treatment progress to achieve precise tooth movements.

This lecture will be delivered through the learning management system of HKAM.

The CME quiz is available for fellows and higher trainees.

Following Lecture 5 and 6, there will be a physical 3-hour hands-on session dedicated to discussing and consolidating the information covered during the lectures for MOrth students.

Orthodontic Biomechanics Series 2024-2025

Lecture 6: Two-Vector Mechanics

In our last session, we explored how to calculate a single force relative to the center of rotation (CRot) and design a custom appliance for desired tooth movement. However, this approach often encounters two challenges. The first challenge is the inaccessibility of the force's application point, which may extend beyond the clinical crown and gingiva. The second is that a force effective in two dimensions might inadvertently cause undesired movement in the third dimension.

To address these issues, we can split the single force into two equivalent forces, applied at accessible points in the oral cavity, to maintain the intended three-dimensional treatment effect. This technique is termed two-vector mechanics.

We will apply two-vector mechanics to a periodontal case presenting with pathological tooth migration, presenting a detailed, step-by-step process. We will revisit the methods for identifying the single force related to the CRot and introduce how to divide this force into two separate, non-concurrent forces.

Furthermore, we will engage in a series of problem-solving exercises, using clinical examples to navigate difficult incisor and molar movements. These exercises will be instrumental in reinforcing the concepts of force equivalency and equilibrium within the context of appliance design.

This lecture will be delivered through the learning management system of HKAM.

The CME quiz is available for fellows and higher trainees.

Following Lecture 5 and 6, there will be a physical 3-hour hands-on session dedicated to discussing and consolidating the information covered during the lectures for MOrth students.

Orthodontic Biomechanics Series 2024-2025

Lecture 7: Six Geometries

During this session, we will use a case study to explore how different force systems are generated during alignment using a two-couple force system. Then, we will demonstrate how six distinct force systems arise when the angulation between two brackets changes.

We will explore the potential complications that arise when applying the two-couple force system. For instance, we will examine situations where the force systems of active and reactive units are not aligned with the intended tooth movement. Additionally, we will introduce the concepts of absolute and relative consistent configurations.

To avoid these issues, we will discuss how to select the right appliance to generate the correct force on the active unit and how to reinforce anchorage for the reactive unit. We will introduce essential concepts of quantitative and qualitative inconstancies to understand the properties of a two-couple force system and contrast these with a one-couple force system. We will also categorize the six geometries into two groups: "Low Geometries" and "High Geometries," each characterized by distinct ranges of force magnitudes and moments.

Based on the identification of low and high geometries, we will introduce the algorithm of tooth movement with moderate displacement which explains how to modify the straight wire appliance or employ various segmented arch appliances to enhance the efficiency of tooth movement with moderate displacement, supported by clinical examples. Our strategies will include:

1. Tying the archwire loosely on the straight wire bracket, tying the archwire under or over the straight wire bracket, switching the straight wire brackets to tip-edge brackets or traction hooks to convert a two-couple force system into a one-couple force system.
2. Segmenting the archwire to avoid unfavorable force systems and excessive force and moment magnitudes.
3. Utilizing box loops and alpha-beta bends (V bends) to create specific force systems that achieve the desired tooth movement.

This lecture will be delivered through the learning management system of HKAM.

The CME quiz is available for fellows and higher trainees.

Following Lecture 7 and 8, there will be a physical 3-hour hands-on session dedicated to discussing and consolidating the information covered during the lectures for MOrth students.

Orthodontic Biomechanics Series 2024-2025

Lecture 8: Alpha-beta bends

The lecture will commence by introducing step and V bends, designed to replicate the force systems of six geometries on two brackets with different angulation in 2D. We will explore the relationship between V bends and truncated V bends, also known as Alpha-beta bends.

We will continue revisiting the algorithm of tooth movement with moderate displacement which was introduced in the last lecture. This section will be reinforced by clinical examples that demonstrate the following strategies:

1. Using V bends and Alpha-beta bends strategically to create specific force systems that facilitate the desired tooth movements.
2. Understanding the theory behind alpha-beta bends and following a detailed workflow for their clinical application.
3. Leveraging one of the limitations of a two-couple force system, which is qualitative inconstancies, to enable complex tooth movements that may not be possible with standard approaches.

This lecture will be delivered through the learning management system of HKAM.

The CME quiz is available for fellows and higher trainees.

Following Lecture 7 and 8, there will be a physical 3-hour hands-on session dedicated to discussing and consolidating the information covered during the lectures for MOrth students.

Orthodontic Biomechanics Series 2024-2025

Lecture 9: Use of TPA and lingual arch for symmetrical movement

This lecture explores the application of the Transpalatal Arch (TPA) and Lingual Arch (LA) in achieving symmetrical tooth movements.

TPA and LA can function as cantilevers with special configurations or alpha-beta bends to produce symmetrical and asymmetrical tooth movements. However, bending these appliances into their deactivated shapes requires careful consideration due to their unique shapes and orientations within the oral cavity. Different types of bends will result in various outcome. Moreover, under the same configuration, the result may also vary due to the duration of the application, as it is a time-dependent force system.

The lecture will cover key concepts such as force-driven and shape-driven methods, the association and dissociation of force and moment, the effects of different activations on the wire's internal stress (bending moment and torsion) and the impact on the deactivation force system.

Through a series of case studies, we will address several clinical challenges to highlight the applications and outcomes:

1. Correction of bilateral scissors bite using functional appliances, alongside symmetrical molar constriction in young patients.
2. Symmetrical molar derotation.
3. Combined symmetrical molar expansion and buccal crown torque.

This lecture will be delivered through the learning management system of HKAM. The CME quiz is available for fellows and higher trainees.

Following Lecture 9 and 10, there will be a physical 3-hour hands-on session dedicated to discussing and consolidating the information covered during the lectures for MOrth students.

Orthodontic Biomechanics Series 2024-2025

Lecture 10: Use of TPA and lingual arch for asymmetric movement

Before the advent of skeletal anchorage, managing asymmetric tooth movement posed significant challenges due to complex anchorage considerations. This lecture begins with traditional yet effective alternatives to miniscrew anchorage, which includes:

1. Free anchorage
2. Reciprocal anchorage
3. Compound anchorage
4. Occlusion anchorage
5. Active anchorage
6. Differential movements anchorage
7. Employing large moments with light forces

The session will also cover practical applications through a series of case studies focusing on challenging molar movements:

1. Combined use of TPA with tip back bend and cantilever intrusion arch for unilateral molar distal tipping.
2. "Open the doors mechanics": a technique involving TPA with molar derotation bends and a cantilever for incisor proclination and unilateral molar derotation and distalization.
3. Replication of "Open the doors mechanics" using miniscrew anchorage for unilateral molar derotation and distalization.
4. Asymmetric molar expansion using a modified quadhelix.
5. Asymmetric expansion or constriction of molars using lingual arches, employing either differential moments anchorage or large moment-light forces methods.

The presentation will further discuss the integration of symmetric and asymmetric molar movements using TPA and lingual arch, combined with various tools such as cantilevers, box loops, alpha beta bends and miniscrew anchorage. The advantages of using this technique in addressing complex issues in orthodontic camouflage and surgical orthodontics will also be elaborated.

We will conclude with a comparative analysis of a case of asymmetric molar derotation and mesialization using a lingual arch cantilever versus a similar case from Lecture 7 involving alpha-beta with lingual arch. This lecture aims to provide a comprehensive understanding of managing difficult molar movements with or without miniscrew anchorage.

This lecture will be delivered through the learning management system of HKAM.

The CME quiz is available for fellows and higher trainees.

Following Lecture 9 and 10, there will be a physical 3-hour hands-on session dedicated to discussing and consolidating the information covered during the lectures for MOrth students.

Orthodontic Biomechanics Series 2024-2025

Lecture 11: Friction and space closure

This lecture will explore several key aspects of friction in orthodontic mechanics, focusing on its role in leveling, alignment and space closure. Key discussion points will include:

1. The Role of Friction in Orthodontics: We will discuss how friction influences leveling, alignment and space closure, covering:
   - The basic friction equation: $F_{Friction} = \mu N$
   - The relationship between applied force and effective force
   - The effects of binding and notching
2. Friction in Teeth with Diminished Bone Support: Analysis of how reduced bone support affects friction during sliding mechanics in three dimensions.
3. Reducing Friction: Strategies for minimizing friction during space closure with sliding mechanics, supplemented by clinical examples.
4. Differential Friction Anchorage: Examination of whether differential friction can be utilized to reinforce anchorage.
5. Eliminating Friction 1: By sectioning the archwire, including relevant clinical examples.
6. Eliminating Friction 2: Loop Mechanics for Space Closure:
   - Discussion on the M/F ratio of different loops and pre-activation techniques for effective space closure.
   - Exploration of tooth movement cycles using T loops and compare it to sliding mechanics.
   - Illustrate the application of T loops with case studies.

The presentation will be followed by a case study detailing anchorage loss during space closure and the subsequent recovery mechanics. This leads to discussions on the following topics:

1. Review of compound, intermaxillary, and differential moments anchorage.
2. Introduction of the anchorage planning chart, used in conjunction with VTO, and occlusogram, which helps pre-treatment planning and mid-treatment monitoring of anchorage across different extraction patterns in sliding mechanics.

This lecture will be delivered through the learning management system of HKAM.

The CME quiz is available for fellows and higher trainees.

Following Lecture 11 and 12, there will be a physical 3-hour hands-on session dedicated to discussing and consolidating the information covered during the lectures for MOrth students.

Orthodontic Biomechanics Series 2024-2025

Lecture 12: Management of skeletal class 3 patients

It is common for skeletal class 3 patients to present with reverse overjet, and the malocclusion often develops as early as in the deciduous dentition. While orthodontists attempt to intercept the problem in growing patients in various ways, a proportion of cases inevitably develop into severe mandibular prognathism and asymmetry, which require combined orthodontic and orthognathic surgery treatment after cessation of dentofacial growth.

Therefore, effective communication throughout the treatment is essential for successful management of these patients, especially in shared decision-making and handling adverse outcomes. On the other hand, recent advances in treatment modalities such as skeletal anchorage, 3D imaging, and computer-assisted treatment planning may improve the quality of growth modification, orthodontic camouflage, and orthognathic surgery.

The focus of the lecture is on different management approaches for skeletal class 3 patients at various ages, highlighting the significance of risk management and the availability of new approaches to improve results, simplify procedures, and reduce risks. Many patients presented in this lecture, who began treatment in early childhood, were followed into adulthood. This longitudinal perspective is particularly valuable for MOrth students, who typically do not have the opportunity to observe such cases over extended periods.

This lecture will be delivered through the learning management system of HKAM.

The CME quiz is available for fellows and higher trainees.

Following Lecture 11 and 12, there will be a physical 3-hour hands-on session dedicated to discussing and consolidating the information covered during the lectures for MOrth students.

Orthodontic Biomechanics Series 2024-2025

Lecture 13: Management of maxillary protrusion and gummy smile

Maxillary dentoalveolar protrusion is a common problem in the Asia-Pacific population, yet its management has not received adequate attention in the scientific literature. Maxillary dentoalveolar protrusion can be presented individually or combined with anterior, posterior, or total vertical maxillary excess and mandibular deformities in three planes of space.

Clinical features commonly seen are gummy smile, increased overjet, and overbite, while the management can be complicated by the presence of mesially tipped molars, posterior crossbite, and dental asymmetry. Some patients who present with anterior open bite make the treatment even more challenging.

Orthognathic surgery was the gold standard in treatment before, as orthodontic camouflage with conventional straight-wire mechanics and premolar extraction often created or aggravated gummy smile by elongating upper incisors during retraction. Proper use of miniscrew anchorage overcomes this pitfall but has created other problems such as over-retraction and intrusion, thus violating the biological limits of the roots, bone, and periodontal support.

Growth modification at puberty may improve occlusion, constricted maxilla, and retrognathic mandible but has little impact on maxillary protrusion and vertical excess. Orthodontic camouflage, which is performed immediately after, is prone to relapse due to subsequent vertical growth in the post-pubertal growth period.

Therefore, rational treatment planning is the key to success. In this presentation, a step-by-step application of an esthetically driven goal-setting and treatment planning algorithm for orthodontic camouflage will be proposed and illustrated by a series of cases with the following details:

1. The use of Visual Treatment Objective (VTO) to set treatment goals, assess biological limits, and differentiate between camouflage and surgical cases.
2. The application of a digital occlusogram to plan anchorage and treatment mechanics.
3. The biomechanics of using a straight-wire appliance in conjunction with miniscrew anchorage to correct maxillary dentoalveolar hyperplasia in sagittal and vertical dimensions through extensive tooth movement.
4. Best timing and phasing of treatment in relation to growth and development.

This lecture will be delivered through the learning management system of HKAM.

The CME quiz is available for fellows and higher trainees.

Following Lecture 13 and 14, there will be a physical 3-hour hands-on session dedicated to discussing and consolidating the information covered during the lectures for MOrth students.

Orthodontic Biomechanics Series 2024-2025

Lecture 14: Orthodontic full mouth rehabilitation of adult patient: An interdisciplinary approach

Adult orthodontic patients are difficult to manage. Their malocclusion is primarily caused by the growth issues of teeth, alveolar bone and jaws. However, trauma, caries, tooth loss and periodontal disease complicate the orthodontic management. Lacking favorable growth and bone support leads to complicated treatment mechanics to bring the drifted teeth back to the original position and open space for tooth replacement. Furthermore, additional dental movement is often require to compensate for the primary malocclusion, including jaw discrepancy to improve stability and function. The involvement of general dentists and specialists is imperative to control the disease and replace missing teeth to achieve satisfactory result.

The final lecture of the series aims to discuss the integration of the face-driven treatment planning, skeletal anchorage, straight wire mechanics and segmented arch technique to manage a series of adult cases with compromised dentition.

This lecture will be delivered through the learning management system of HKAM.

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