Journal of Advanced Medical and Dental Sciences Research

@Society of Scientific Research and Studies *NLM ID: 101716117*

Journal home page: www.jamdsr.com doi: 10.21276/jamdsr Indian Citation Index (ICI) Index Copernicus value = 100

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Review Article

Space Closure in orthodoctics: A Review

[1]Vaishnavi J, [2]Sharda Bhidasra, [3]Adit Arora, [4]Salman KK, [5]Muhammad Nihal K, [6]Syed Ramsha Ali, [7]Varun Lohia

[1,2,4,5,6,7]Post Graduate student, [3]Professor and Head, Department of Orthodontics, Maharaja Ganga Singh Dental College and Research Centre, Sriganganagar, Rajasthan, India

ABSTRACT:
Understanding the biomechanical basis of space closure better enables clinicians to determine anchorage and treatment options. In spite of the variety of appliance designs, space closure can be performed by means of friction or frictionless mechanics, and each technique has its advantages and disadvantages. Retraction is the most frequently used technique in space closure. The strategy used in retraction mechanics must be based on a careful diagnosis and treatment plan made according to the specific needs of the individual. Unfortunately, there have been limited attempts to compare between the two main space closure methods in literature and a systematic review comparing en masse and two-step retraction has not been undertaken. The present review highlights the need for space closure, and methods of space closure.
Keywords: Space closure, Friction mechanics, Biomechanical.

Received: 10 March, 2025 Accepted: 18 April, 2025 Published: 12 May, 2025

Corresponding Author: Vaishnavi J, Post Graduate student, Department of Orthodontics, Maharaja Ganga Singh Dental College and Research Centre, Sriganganagar, Rajasthan, India

This article may be cited as: J Vaishnavi, Bhidasra S, Arora A, KK Salman, K Muhammad N, Ali SR, Lohia V. Space Closure in orthodoctics: A Review. J Adv Med Dent Scie Res 2025; 13(5):78-82.

INTRODUCTION

Space closure is one of the most challenging processes in Orthodontics and requires a solid comprehension of biomechanics in order to avoid undesirable side effects. The different methods to close spaces, reduce procumbence, overjet, and eliminate extraction sites by antero-posterior therapy is generally categorized as **Retraction mechanics.** Whether retracting the anterior or protracting the posterior or a combination of both principles of retraction mechanics apply for space closure remains the same.[1] Retraction is the most frequently used technique in space closure. The strategy used in retraction mechanics must be based on a careful diagnosis and treatment plan made according to the specific needs of the individual. **Two step retraction** and **en mass retraction** are two most used mechanics in anterior retraction. In two step retraction; retraction of canine teeth is done followed by retraction of all four incisors and en mass retraction involves retraction of all six teeth.[2] Space closure is one of the main stages of orthodontic treatment when extractions are undertaken as part of the treatment plan.[3] Space closure can be achieved using one of the two methods, either sliding mechanics (frictional mechanics) or closing loops (frictionless mechanics). The use of those two methods depends mainly on the treatment plan, appliance used, and the clinician's preference.[4,5] The choice of either of these techniques depends on the clinician's experience and preference.[6]

HISTORY

- **Ray D Robinson** was the first to introduce loop for retraction purposes long back during Angle era.[7]
- Segmental arch technique under frictionless mechanics was popularized by **Burstone** et al.[8]
- The PG retraction spring is another popular spring based on segmental arch mechanics, can be made from 0.016"x 0.022" stainless steel wire or TMA.[9]
- Opus loop is a closing loop design based on **Castigliano's theorem** for the derivation of moment to force ratio, best suited in continuous SS or TMA arch wire.[10]
- A mushroom loop was fabricated by **Nanda** and It is similar to the design of T loop except that its apical area is curved.[11]
- **Bennett and Mclaughlin** popularized the use of

Active tie back (elastomeric module with ligature) for retraction during the development of their well-known MBT philosophy.[1]
- An invasive procedure known as Dental Distraction was first performed by **Liou, and Huang** for the purpose of rapid canine retraction. A different technique called Dento-Alveolar Distraction (DAD) for acceleration of canine distalization by performing osteotomies around the canines and achieved rapid tooth movement.[12]
- Periodontally Accelerated Osteogenic Orthodontics (PAOO) is a method to stimulate RAP (Regional Acceleratory Phenomenon) via conventional corticotomy and use of bone graft material. An alternative limited invasive procedure is known as Piezocision technique described in 2009 by **Dibart** et al.[1]
- **Dr. Robert H.W Strang** (1933) - vertical loop design for edgewise mechanics.
- **Dr. P. R. Begg** (1952) - in the initial phase of Begg treatment.[5]

Need for space closure

Six goals should be considered for any universal method of space closure[13]:
1. Differential space closure, the capability of anterior retraction, posterior protraction or a combination of both.
2. Axial inclination control.
3. Control of rotation and arch width.
4. Optimum biologic response.
5. Minimum patient cooperation and
6. Operator's convenience.

Space closure requires the clinician's ability to predict force system and control tooth movement after due consideration of the periodontal tissues.

Orthodontic tooth movement during space closure is achieved through two types of mechanics:[14]

1. Segmental or Sectional mechanics:

Segmental mechanics involves, closing fabricated loops either in a full or sectional arch wire. Since sectional mechanics do not involve friction; it is also called the **friction-free or frictionless technique**. The teeth move by activation of the wire loop and can be designed to provide a low load deflection rate and controlled moment-force ratio.

2. Sliding mechanics:

Sliding mechanics involves, moving of the teeth along an arch wire through brackets and tubes. Since, friction plays a significant role in sliding and space closure, therefore the name **friction mechanics** is often associated with it.

Orthodontic space closure should be individually tailored based on the diagnosis and treatment plan. The selection of any treatment, whether a technique, stage, spring or appliance designs, should be based on the desired tooth movement. Consideration of the force system produced by an orthodontic device aids in determining the utility of the device for correcting any specific problem.

DETERMINANTS OF SPACE CLOSURE
1. Amount of crowding
2. Anchorage
3. Axial inclination
4. Midline discrepancies and left or right asymmetries
5. Vertical dimension

C

LASSIFICATION OF RETRACTION MECHANICS[14]

Based on wire configuration:

a. Continuous arch mechanics - Indeterminate force system.

b. Segmental arch mechanics -Determinate force system.

Based on type of tooth movement:

a. Friction mechanics - sliding mechanics.

b. Frictionless mechanics - uses of loops or specialized springs.

Based on type of tooth movement:

a. Tipping and uprighting - Begg and Tip Edge system.

b. Translation-Standard Edge wise and Pre adjusted Edgewise appliance.

Based on mode of retraction:

a. Single cuspid retraction.

b. Enmasse retraction.

Based on Anchorage :

a. Type A- Maximum Anchorage

b. Type B- Moderate Anchorage

c. Type C-Minimum Anchorage

Orthodontic Methods And Techniques For Space Closure[15]

Orthodontic treatment planning is more than just deciding on extraction or non-extraction. Although many approaches towards space closure have been described, the biomechanical principles defining the nature of the force systems applied show many similarities among diverse techniques.

Friction mechanics[15]

Friction is a force that retards or resists the relative motion of two objects in contact. Friction is a clinical challenge, particularly with sliding mechanics, and must be dealt with efficiently to provide optimal orthodontic results.

The ability to quantify and control friction will lead to;
- less anchorage loss, more predictable tooth movement,
- the use of ideal force levels to overcome friction and optimize physiological tooth movement.

Not all friction in the orthodontic appliance is detrimental to tooth movement. Tooth movement, such as below mentioned do require friction to work,
- The correction of rotated teeth,
- Set-up of anchor units, or
- Uprighting of angulated teeth

- As the tooth moves in the direction of the applied force, kinetic friction occurs between the bracket and archwire

COMPONENTS OF FRICTION

In PEA and Edgewise system, resistance to sliding (RS) of an arch wire bracket couple is the combined effect of up to 3 components.

1. Classical friction (FR).
2. Elastic binding (BI).
3. Physical notching (NO)

RS = FR + BI + NO **CLASSICAL FRICTION**

- When clearance is present, only classical friction (FR) is present (passive region).
- The normal force (N) that presses the archwire into the bracket and the frictional coefficient (µ) of the archwire-bracket couple govern the value of FR. FR = µ N
- The magnitude of µ is only a function of the surface interactions.
- The FR dominates RS until clearance is eliminated.

CRITICAL CONTACT ANGLE (Θc)

The initial second-order angle (θ) at which clearance no longer exists due to angulation has been designated as θc

θc = 57.3(Clearance Index)

Bracket Index: Width/Slot

Clearance Index: 1- Engagement Index Engagement Index: Size/Slot

Engagement index- This index defines the fraction of the bracket slot filled by the arch wire.

Bracket index - the number of times the bracket width is more than slot dimension.

Together, these two dimensionless indices define all that is necessary to determine θc as the point at which the binding starts.

When the nominal parameters of arch wire and bracket used in sliding mechanics were estimated for critical contact angle, three important conclusions were drawn.

1. Narrow bracket showed θc double the value when compared to the wider brackets.
2. Smaller bracket slot showed decreased θc value. Hence, more precise aligning and leveling is required before retraction.
3. Smallest wires used for retraction i.e. 16 size wire in 22 slot, 125mil width. θc = 2.8 degrees. Same wire in 18 slot showed θc = 0.9 degrees

VARIABLES AFFECTING FRICTIONAL RESISTANCE DURING TOOTH MOVEMENT[16]

A. PHYSICAL

- Archwire
- Material.
- Cross sectional shape/ size.
- Surface texture.
- Stiffness.

Ligation of archwire to bracket.

- Ligature wires.
- Elastomerics.
- Methods of ligation.

Bracket*:*

- Material.
- Manufacturing process.
- Slot width and depth.
- Design of bracket.
- First-order bend (in-out).
- Second order bend (angulation).
- Third order bend (torque).

Orthodontic appliance

- Inter bracket distance.
- Level of bracket slots between adjacent teeth.
- Forces applied for retraction.

B. BIOLOGICAL

- Saliva.
- Plaque.
- Acquired pellicle.
- Corrosion

RETRACTION BY IMPLANTS[17]

The type of tooth movement that can be produced with microimplant anchorage is determined by the same biomechanical principles and considerations that operate during conventional orthodontic treatment, eg, force, moment, center of resistance, center of rotation. The following are various clinical protocols that can be used routinely for effective tooth movement using microimplant anchorage. Three types of en masse retraction mechanics in extraction cases based on the height of microimplant relative to the occlusal plane.

Maxillary anterior en masse retraction mechanics in extraction cases;

For maxillary anterior en masse retraction, the line of action and the moment created will vary depending on the location of the microimplant relative to the occlusal plane. En masse retraction mechanics in extraction cases can be classified into three categories much like the descriptors used traditionally for headgear traction: low-, medium-, and high-pull mechanics.

Medium-Pull Mechanics for the Maxillary Arch;

Maxillary microimplants usually can be placed buccally between the second premolar and first molar roots for anterior en masse retraction. When a maxillary microimplant is placed about 8 to 10 mm above the main archwire, the term medium- pull en masse retraction mechanics is used.

Anterior enmasse retraction mechanics in extraction cases:

Medium-Pull Mechanics for the Mandibular Arch:

Mandibular microimplants usually are placed buccally between the second premolar and first molar roots for anterior en masse retraction. When a mandibular microimplant is placed 6 to 8 mm away from the main archwire, the term medium-pull en masse retraction mechanics is used. If force is directed from a medium-pull microimplant to a hook located between the lateral incisor and canine that extends 4 to 6 mm below the main archwire, the mandibular occlusal plane usually can be maintained. Therefore, medium-pull mechanics are useful in treating patients who have normal overbite relationships.

Low-Pull Mechanics for the Mandibular Arch:

When a microimplant is placed buccally between the roots of the mandibular second premolar and first molar and is less than 6 mm away from the main archwire, the term low-pull en masse retraction mechanics is used. If force is applied from a microimplant in a low-pull location to an anterior hook extending 4 to 6 mm below the main archwire, a counterclockwise rotation of the mandibular occlusal plane typically can be achieved. Low-pull mechanics are useful in treating patients who have an openbite or openbite tendency.

High-Pull Mechanics for the Mandibular Arch:

High-pull en masse retraction mechanics result when a microimplant is placed buccally between the mandibular second premolar and first molar roots and more than 8 mm away from the main archwire. If force is applied from a high-pull microimplant

Low-Pull Mechanics for the Maxillary Arch;

When a microimplant is placed buccally between the roots of the maxillary second premolar and first molar and is less than 8 mm away from the main archwire, the term low-pull en masse retraction mechanics is used. If force is applied from a low-pull microimplant to an anterior hook extending 6 to 7 mm above the main archwire, the maxillary occlusal plane usually can be rotated in a clockwise direction. Therefore, low- pull mechanics are useful in treating patients who have an openbite or an open- bite tendency.

- The mandibular occlusal plane can be maintained by anterior enmasse retraction, if medium-pull sliding mechanics is used.
- The mandibular occlusal plane will rotate in a counter clockwise direction during anterior en masse retraction, if low-pull sliding mechanics is used.

The mandibular occlusal plane will rotate in a clockwise direction during anterior en masse retraction, if high-pull sliding mechanics is used.

CONCLUSION

As the field of orthodontics has evolved, the options and techniques of mechanotherapy have expanded significantly. Advances in bracket design, wire alloys and even bonding techniques have increased clinical options. So many of new appliances, arch wires and brackets are wonderful. But however, they cannot be placed automatically by an auxiliary to produce an automatically esthetic, healthy, functional and stable result. Undesired or inefficient tooth movement during orthodontic treatment results from individual variations in biologic response and the improper use of forces. Applications of the rules of biomechanics allow one of these sources of variation to be reduced or eliminated. Appliance will always act according to the LAWS OF PHYSICS. Understanding the basic biomechanical principles involved in effective controlled tooth movement makes the outcome more predictable and consistent.

REFERENCES

1. Mc Lauglin, Benett, Trevisi Systemized Orthodontic Treatment Mechanics. Mosby Elsevier. (2001); 249-277.
2. R.H.A. Samuels, S.L. Rudge. A Clinical study of Space Closure with Nickel-Titanium closed Coil Springs and an Elastic Module. Am J Orthod Dentofac Orthop.(1998); 114: 73-9
3. Gjessing P: Biomechanical Design and Clinical Evaluation of a New Canine Retraction Spring. Am J Orthod Dentofac Orthop.(1985); 87:353-362.
4. Lewis PD. Space closure in extraction cases. Am J Orthod. 1950;36:172–91.
5. Graber TM. The edgewise appliance in routine practice. Am J Orthod. 1960;46:1–23
6. Louis: Elsevier Health Sciences; 2014. 13. Kulshrestha RS, Tandon R, Chandra P. Canine retraction: a systematic review of different methods used. J Orthod Sci. 2015;4:1
7. Robinson RD. A system of positive and painless tooth movement. Int J Orthodontia. 1915;1(10):497–509.
8. Stoner MM, Lindquist JT. The edgewise appliance today. Current orthodontic concepts and techniques. Philadelphia: WB Saunders Company; 1969.
9. Gjessing P. Biomechanical Design and Clinical Evaluation of a New Canine Retraction Spring. Am J Orthod Dentofac Orthop.1985;87:353–62.
10. Siatkowski RE. Continuous arch wire closing loop design, optimization, and verification. Am J Orthod Dentofacial Orthop.1997;112(4):393–402.
11. Nanda R. Esthetic and Biomechanical Strategies for Clinical Orthodontics. WB Saunders; 2005. p. 194–210.
12. Aboalnaga AA, Fayed MMS, El-Ashmawi NA, Soliman SA. Effect of micro-osteoperforation on the rate of canine retraction: a split mouth randomized controlled trial. Prog Orthod. 2019;20(1):21.doi:10.1186/s40510-019-0274-0.
13. Dr. Vijay Adith, Dr. Deenadayalan Purushothaman, Dr. Monica Pisupati, “Friction Mechanics – A Review”, IJMSIR- February - 2020, Vol – 5, Issue -1, P. No. 46 – 55.
14. Dixon V, Read MJ, O’Brien KD, Worthington HV, Mandall NA. A randomized clinical trial to compare three methods of orthodontic space closure. J Orthod. 2002;29(1):31–6. doi:10.1093/ortho/29.1.31.
15. Proffit WR, Fields HW, Sarver DM. Contemporary

orthodontics. Elsevier Health Sciences; 2006.\
16. AlSubie M, Talic N (2016) Variables affecting the frictional resistance to sliding in orthodontic brackets. Dent Oral Craniofac Res 2: doi: 10.15761/DOCR.1000160.
17. Almeida MR. Biomechanics of extra-alveolar mini-implants. Dental Press J Orthod. 2019 Sep 5;24(4):93-109. doi: 10.1590/2177-6709.24.4.093-109.sar. PMID: 31508712; PMCID: PMC6733231.