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Methods of Gaining Space:-A Review

Review article

Aameer Parkar[1], Pavan Kumar Vibhute[1], Chetan Patil[1], Vinay Umale4[1], Rohit Kulshrestha[1*] and Kshama Chandurkar[2]

[1]*Department of Orthodontics and Dentofacial Orthopedics, Yogita Dental College, India*
[2]*Department of Oral Pathology, Yogita Dental College, Khed, Maharashtra, India*

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***Corresponding author:** Dr Rohit Kulshrestha, Senior Lecturer, Department of Orthodontics and Dentofacial

Introduction

Irregularities of the teeth and their occlusion have been found in human skulls dating as far back as Neanderthal man of 50,000 to 60,000 years ago. From our ancestors to the present man, the evolutionary trend has been one of reduction of facial dimensions. Genetic drift has allowed for diminution in both the skeletal framework of the face and the dentition. Man's facial dimensions however, are getting smaller at a greater rate than his teeth and these results in an increasing tendency towards dental crowding and protrusion of teeth.

The teeth and jaws to a great extent contribute in making or marring the beauty of face. A beautiful face is well proportioned; one with correct relationship between jaws and a set of well-aligned teeth, while imbalance in these structures is malocclusion.

Severe malocclusion leads to functional as well as psychological disturbances in the patient. The orthodontist while treating various malocclusions requires space to move teeth into a more ideal position.

Literature for gaining space dates back to as early as 1723, when Pierre Fauchard, the founder of modern dentistry, devised an appliance called "Bandelette" to expand the arches. Later, the concept of extraction of deciduous teeth and some permanent teeth came with Robert Bunon in 1743. In 1860, Emerson Angell, for the first time, used jackscrew type of device for rapid maxillary expansion.

Expansion and extraction were the only methods that ruled the 18th and 19th century as the methods of gaining space [1]. Later, several methods were introduced.

In the present era, we have the following methods of gaining space

1. Expansion.
2. Proclination of anteriors.
3. Extraction.
4. Proximal stripping.
5. Molar distalization.
6. Uprighting of molars.
7. Derotation of posterior teeth.

Physiologic space

The only way to relieve crowding in an arch is to create space to accommodate the actual number of teeth in the arch to their harmonious occlusion. The patient is mostly seen during mixed or permanent dentition, when we the orthodontists try to gain space, by orthodontic means, to relieve crowding. However, physiologic spaces in dentition exist from the time of early development of occlusion.

Occlusal development can be classified into different periods as -

1) Pre dental period

2) The deciduous dentition period

3) The mixed dentition period

4) The permanent dentition period [2]

The Pre-Dental Period

It is the period after birth during which the neonate does not have any teeth. It usually lasts for 6 months after birth.

At birth, the gum pads are not sufficiently wide to accommodate the developing incisors, which are crowded in their crypts. During the first year of life, the gum pads grow more rapidly permitting the incisors to erupt in good alignment.

The Deciduous Dentition Period

This period starts from the eruption of lower incisors and continues till the second deciduous molars come into occlusion.

Spacing in deciduous dentition: Spacing usually exists in deciduous dentition. These spaces are called Physiologic or developmental spaces. The presence of spaces in primary dentition is important for normal development of permanent dentition. The absence of spaces indicates that crowding may occur in the permanent dentition.

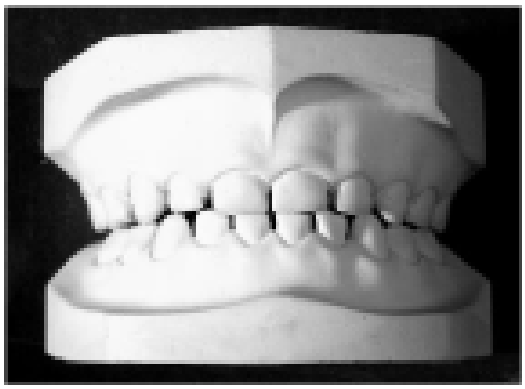

Figure 1: Spaces in deciduous dentition

Spacing invariably is seen mesial to maxillary canines and distal to mandibular canines. These physiologic spaces are called 'Primate', 'Simian' or 'Anthropoid' spaces as they are mostly seen in primates. These spaces help in the placement of canines of the opposing arch.

The Mixed Dentition Period: The Mixed dentition period begins at approximately 6 years of age with the eruption of first permanent molar. During the mixed dentition period, the deciduous teeth along with some permanent teeth are present in the oral cavity.

The mixed dentition period can be classified into three phases-

1) First transitional period

2) Inter transitional period

3) Second transitional period

1] First transitional period:

It is characterized by the emergence of first permanent molars and the exchange of deciduous incisors with permanent incisors.

Mostly the distal surface of upper and lower second deciduous molars are in one vertical plane (Flush or vertical terminal plane). Thus, the erupting first permanent molars may also be in a flush or end-on relationship. For the transition of such an end-on molar relation to Class I molar relation, the mandibular molar has to move forward by about 3-5 mm relative to the maxillary molar. This occurs by utilization of the physiologic spaces and Leeway space in the lower arch and by differential forward growth of the mandible. The shift in lower molar can occur in two ways:

I] Early shift: This occurs during early mixed dentition period. The eruptive force of first permanent molar is sufficient to push the deciduous first and second molars forward in the arch to close the primate space and thereby establish a Class I molar relationship.

II] Late shift: Many children lack primate spaces and thus the erupting permanent molars are unable to move forward to establish a Class I relationship. In these cases, when the deciduous second molars exfoliate, the permanent first molars shift mesially utilizing the Leeway space. This occurs in the late mixed dentition period and is thus called 'late shift'.

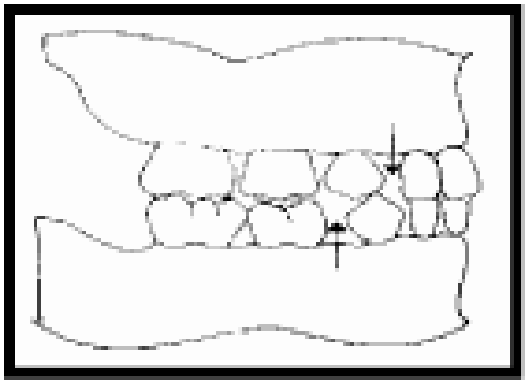

Figure 2: Primate spaces

Exchange of incisors

Deciduous incisors are smaller than permanent incisors, the difference being called the 'Incisor liability'. It is about 7 mm in the maxillary arch and about 5 mm in the mandibular arch. It is overcome by utilizing the Physiologic spaces and by increase in the inter-canine width in maxillary and mandibular arches.

2] Inter transitional period:

It consists of sets of deciduous and permanent teeth and this period is relatively stable.

3] Second transitional period:

This period is characterized by the replacement of the deciduous molars and canines by the premolars and permanent cuspids.

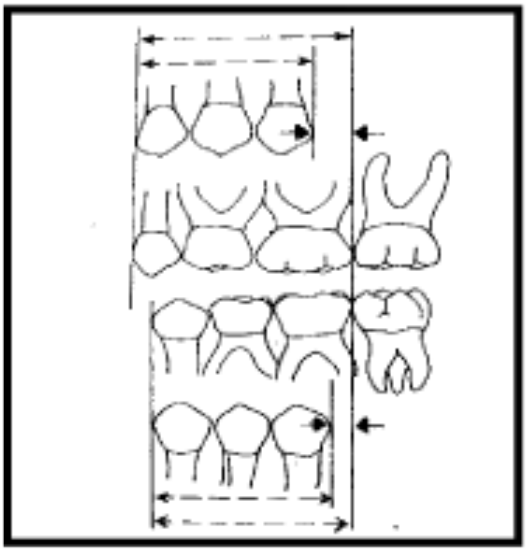

Figure 3: Leeway space of Nance

The combined mesio-distal width of the permanent canines and premolars is usually less than that of the deciduous canines and molars. The surplus space is called 'Leeway space of Nance' . The amount of Leeway space is greater in the mandibular arch than the maxillary arch. It is about 1.8 mm (0.9 mm on each side of arch) in the maxillary arch and 3.4 mm (1.7 mm on each side of the arch) in the mandibular arch. This excess space available after the exchange of the deciduous molars and canines is utilized for mesial drift of the mandibular molars to establish a Class I relationship.

There are various etiologic factors, which disrupt the normal pattern of occlusal development leading to malocclusion, which then has to be treated by orthodontist

Expansion

Expansion is the oldest clinical method of gaining space. In 1723, the first orthodontic appliance was developed by Pierre Fauchard. It was an expansion appliance named as "Bandelette" designed to expand the arches, particularly the anterior teeth.

Expansion is a tempting means of gaining space with the added advantage of being a conservative procedure. It has been stated that posterior crossbites appear at fairly constant rate in malocclusion. This implies that this abnormality develops early and is not self-correcting. Expansion can be done in an anteroposterior direction, lateral direction or a combination. The orthodontist in his therapeutic armamentarium has several effective expansion appliances, which may be removable, semifixed or fixed [3-5].

The orthodontist has a number of appliances, which can be used for arch expansion. The appliances used for arch expansion can be divided into numerous ways.

(A) On The Basis Of The Region To Be Expanded Or Direction of Expansion

(a) Expansion in the lateral direction –

- Can be unilateral or bilateral.
- The most common example is that of cross bites of the buccal segments.
- e.g. expansion by screw, rapid palatal expansion.

(b) Expansion in the anteroposterior direction –

- Can be unilateral or bilateral.

- e.g. anterior maxillary crossbites cases.

(c) Expansion in anteroposterior as well as lateral direction –

- For e.g. "Y" shaped expansion screw.

(d) Expansion for distalization of segment of teeth –

- For e.g. in cases of retraction or molars.

(B) On The Basis Of Appliance Used For Expansion

(a) Removable appliances - e.g. Coffin spring

(b) Semifixed appliances – e.g. Modular 3D appliance

(c) Fixed appliances - e.g. Hyrax screw.

(C) On The Basis of Type of Effect Caused By The Forces

(a) Orthodontic expansion or slow expansion:

- Expansion of dental arches can be produced by a variety of orthodontic treatments including those that employ fixed appliance.
- Coffin spring is the best example of true orthodontic expansion as the changes that are produced primarily affect the dentoalveolar portion.
- Orthodontic expansion of the dental arches produces lateral movement of the posterior buccal segments, with a tendency towards tipping of the crown and resultant lingual tipping of the root.

(b) Passive expansion

- When the forces from the buccal and labial musculature are shielded from the occlusion a widening of the dental arches often occurs.
- This expansion is not produced through the application of extrinsic biomechanical forces but rather by intrinsic forces such as those produced by the tongue.
- e.g. passive expansion in Frankel appliance.

(c) Orthopaedic expansion

- Rapid Palatal Expansion is the best example of the orthopaedic expansion, in that changes are produced primarily in the underlying skeletal structure rather than by the movement of teeth through alveolar bone.
- Rapid Palatal expansion not only separates the mid palatal suture but also affects the circumzygomatic and circummaxillary sutural system. After the palate is widened, new bone is deposited in the area of expansion so that the integrity of the mid palatal suture usually is re-established.

Extraction

'To extract or not to extract' has been a key question in planning orthodontic treatment for more than 100 years. In orthodontics, there are two major reasons to extract teeth [6-8] -

1) To provide space to align the remaining teeth in the presence of severe crowding, and

2) To allow teeth to be moved, usually the incisors to be retracted, so protrusion can be reduced or skeletal Class II or Class III problems can be camouflaged.

There are some alternatives to extraction, but in some cases extraction provides the best treatment and stability. Opinions as to the indications for extraction have changed remarkably over the years, from one extreme to the other and back, and it seems likely that this particular pendulum is still swinging.

Extraction in Orthodontia includes serial extraction carried out as an interceptive procedure and therapeutic extractions carried out as a treatment procedure for gaining space.

Criteria for extraction

The following criteria need to be considered during diagnosis -

(I) Type of malocclusion

(a) In Class I

Contemporary guidelines for orthodontic extraction in Class I crowding and / or protrusion can be summarized as follows –

- Less than 4mm arch length discrepancy extraction rarely indicated (only if there is severe incisor protrusion or in a few instances, a severe vertical discrepancy).
- Arch length discrepancy 5 to 9mm – non-extraction or extraction treatment possible. Decision depends on both the hard and soft tissue characteristics of the patient and on how the final position of the incisors will be controlled; any of several different teeth could be chosen for extraction. Non-extraction treatment usually requires transverse expansion across the molars and premolars.

- Arch length discrepancy 10mm or more; extraction almost always required to obtain enough space. The extraction choice is four first premolars or perhaps upper first premolars and mandibular lateral incisors; second premolar or molar extraction rarely is satisfactory.

(b) In Class II

The critical importance of deciding on surgery or camouflage at the beginning of treatment is illustrated by the difference in extractions needed with the two approaches.

In Camouflage treatment, extraction spaces are used to produce dental compensations for the jaw discrepancy and the extractions are planned accordingly. For example, with orthodontic treatment alone, a patient with mandibular deficiency and a Class II malocclusion might have upper first premolars removed to allow the retraction of the maxillary anterior teeth.

Extraction in the lower arch would be avoided or if necessary because of leveling or alignment requirements, the second premolars might be chosen to provide needed arch length while avoiding retraction of lower anterior teeth.

In surgical treatment, the extraction pattern for this same patient would be quite different if mandibular advancement were planned. Instead of creating dental compensation for the jaw deformity, the orthodontic treatment now would be planned to remove dental compensation, prior to surgical correction of jaw relationship. Premolar extraction in the lower arch but not in the upper often is needed. Removal of lower arch premolars would allow leveling of the arch and correction of lower anterior proclination often associated with this malocclusion. Often in mandibular deficiency patients the position of upper incisors relative to the maxilla is normal. If so, retracting them would be undesirable. The upper arch would be treated without extraction, or if some space were needed because of arch length discrepancy, extraction (such as maxillary second premolar) would be planned to avoid compromising the mandibular advancement by over retraction of the upper anterior teeth.

(c) In Class III

In Camouflage treatment, a similar but reversed situation would be seen in a patient with skeletal Class III problem. If camouflage were planned, typical extractions might be lower first premolars alone, or lower first and upper second premolars. As a general rule, Class III problems are less amenable to camouflage than Class II, because retracting the lower incisors may make the chin appear even move prominent, not what is desired in camouflage.

Surgical treatment of the same patient would require extraction of upper first premolars so that upper incisors could be retracted, correcting their axial inclination and increasing the reverse over jet. If space is needed in the lower arch, second rather than first premolar extraction would be a logical choice so that lower incisors were not retracted.

Proximal stripping

Interproximal enamel reduction is a very simple technique to use in Orthodontics, contrary to other space – gaining systems.

Proximal stripping is a method by which the proximal surfaces of teeth are sliced so as to reduce the mesiodistal width of teeth.

Stripping is a method of resolving mild to moderate crowding by comprehensive interproximal reduction of enamel, primarily in buccal segments.

Indications

1) Mild to moderate crowding in anterior areas in patients with Class I malocclusion.
2) Patients with relapse of as much as 3mm in mandibular arch and 4mm in maxillary arch.
3) Low susceptibility to caries.
4) Appropriate tooth shape If the Bolton's analysis shows a mild tooth material excess in either of the arches, it is possible to reduce tooth material by proximal stripping.

Contraindications

1) Patients with poor oral hygiene, since they are at increased risk of developing interproximal caries.
2) Absolutely contraindicated in patients who have gingivitis.
3) Young patients, as they possess a large pulp chamber which increases the risk of a pulpal exposure [9].

Molar distalization:

The concept of "distal driving" of the maxillary posterior teeth has a long orthodontic history. After early cephalometric studies showed that little or no distal

movement of upper molars was produced by the Class II elastic treatment of that era, headgear was re-introduced as a means of moving the upper molars back. Calvin Case was first to mention the distalization of molars with the help of extra oral force in 1921.

Distalization of molars is one of the methods to gain the space for correction of teeth. It can be brought about by

Ø Extraoral appliance

Ø Intraoral appliance

The extraoral appliance appliance basically constitutes the assembly of headgear or neckstrap and the facebow, which exerts pressure on molars. The anchorage is taken from cervical and cranial region.

These extraoral appliances have some disadvantages such as patient's cooperation and appliances are usually not worn continuously. Thus intermittent action results in longer treatment time.

Most of the intraoral appliances are fixed to the teeth. They exert continuous pressure on the teeth. Also patient's compliance is not necessary.

Morerecently, palatal anchorage has been used to create a space in to which the anterior teeth can be retracted.

The major advantage of distalizing therapy is, it reduces the treatment time significantly. Various studies have reported that the non-extraction treatment takes less time as compared to the extraction treatment.

Extra oral force for molar distalization

The use of headgear therapy is very common in the treatment of Class II div.1 malocclusion. Extra oral maxillary traction appliances are used to improve the dental relationship between maxilla and mandible, as well as the skeletal relationship between the two jaws [10-12].

In orthodontic therapy, extra oral force is primarily used for two purposes:

1. To correct dental arch relationship.
2. As an anchorage to support teeth that would be displaced while other movements are being carried out

Ideal requirements of intra oral molar distalization appliances [13]

1. Minimal need for patient compliance
2. Acceptable esthetics and comfort
3. Minimal loss of anterior anchorage (as evidence by axial proclination of the incisors)
4. Bodily movement of molars to avoid undesirable side effects, lengthening of treatment, and unstable results
5. Minimal chair time for placement and reactivation

Molar uprighting

Loss of posterior teeth, usually first permanent molars is a frequent problem in adults The sequel to this depends on the position and number of the teeth lost, the age at which it occurs, the time elapsed since loss and the occlusal relationships [14].

Since the first molar is so frequently lost, one often sees the second and third molars tipped mesially, rotated, and in a position that is conducive neither to long-term health nor to simple restorative procedures. In addition, the premolars may have drifted distally and rotated, resulting in open contacts and poor marginal ridge relationship. The opposing teeth may supraerupt into the edentulous spaces, further complicating restorative procedures and frequently contributing to occlusal interferences especially in protrusive and extrusive movements. The treatment objectives should be to restore the normal tooth position prior to prosthetically replacing the missing tooth or teeth. Molar uprighting is also one of the methods of gaining space in relieving the crowded arch.

When planning molar uprighting, a number of inter related questions must be answered:

1) The first is, if the third molar is present, whether both second and third molar should be uprighted. For many patients, distal positioning of the third molar would move this tooth into a position where good hygiene could not be maintained or the uprighted third molar would not be in functional occlusion. In these circumstances, it is more appropriate to extract the third molar and simply upright the remaining second molar tooth.

2) The second question is whether to upright the tipped teeth by distal movement (tipping) which would increase the space available for a later pontic, or by mesial root movement, which would maintain or reduce the edentulous span or even close the extraction space, thereby eliminating the need for a bridge. This decision will depend on the position of the opposing teeth, the occlusion desired, the anchorage available for such movements and perhaps most importantly, the contour

of the bone in the edentulous ridge area. If extensive ridge resorption has already occurred, particularly in the buccolingual dimension, mesial movement of a wide molar root into the narrow alveolar ridge will proceed very slowly and can result in a dehiscence of bone on the mesial, buccal and lingual root surfaces, which would not be conducive to long term physiological health. In such cases, distal uprighting of molars is preferred.

3) The third question is whether slight extrusion is permissible or maintenance of the existing occlusal height is required as the uprighting occurs. Tipping the tooth distally generally extrudes it. This has the merit of reducing the depth of pseudopockets found on the mesial surface, and since the attached gingiva follows the cemento-enamel junction while the mucogingival junction remains stable, it also increases the width of keratinized tissue in that area. In addition, if height of crown is systematically reduced as uprighting proceeds, the ultimate crown root length ratio will be improved. In contrast, maintaining the existing occlusal level as the tooth uprights may require actual intrusion which carries with it at least the theoretic possibility of increasing the pocket depth and of relocating infected crevicular tissue further sublingually. Moreover, intrusion of molars is technically difficult, requiring precisely directed and gentle long acting forces.

4) The final question is whether the premolars should reposition as part of the treatment. This decision will depend on the position of these teeth, the existing contacts and the opposing intercuspation, and the restorative plan, but in most cases the answer is yes. It is particularly desirable to close spaces between premolars when uprighting molars, because this will improve the long-term stability.

Derotation

Rotation is defined as perversion of the tooth around its long axis [15].

There are two types of tooth rotations.

(1) Axial

(2) Pivotal

Axial rotation is inferred as turning of the tooth on its central vertical axis.

Pivotal rotation is turning of the tooth on its mesial vertical axis.

When molar is axially rotated with its mesial-in and distal-out, then to derotate it the center of rotation should lie at the center of resistance of the tooth.

When molar is pivotally rotated with its distal end stationary and mesial end lingually, then only the mesial aspect of second molar should be moved which can be achieved only when the center of rotation lies at the distal contact point.

Mild to moderate rotation of incisors, canines and premolars can be corrected by engaging low load deflection wires into PEA brackets. Severe rotation requires application of couple mechanics. Derotation of posterior teeth helps in gaining the space for correction of arch discrepancy.

Conclusion

1. The accelerating pace of changes in orthodontics presents new challenges and problems. The changes are profound and may be uncomfortable to some. The old ways of treatment may not suffice and all of us need to keep our eyes and ears open.
2. The orthodontist is primarily an architect of the face. He is at the same time an engineer who has to implement his architectural design in the correct biomechanical sense. In this process he has to use various methods, materials, procedures and techniques. In all his endeavors, he is buffeted by changes and is forced to cope with everything from changed clinical thinking to becoming versatile with the use of everchanging materials and technologies.
3. Today, with the use of digital technology and a more sophisticated, customized treatment plan procedure; the orthodontist has at his disposal several methods of gaining space and correcting the malocclusion depending on individual case requirements. Orthodontists are free to consider any solution to this problem as long as its helps reach their objective and gives the patient the “smile” they want.

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