3D Retraction Force Vector Indicator for Anterior en masse Retraction with Miniscrew Anchorage

Pavankumar Janardan Vibhute

ABSTRACT

Miniscrews are used for providing anchorage in orthodontics and have become an integral part in the orthodontic treatment of severely protrusive patients for maximum retraction of anterior teeth after premolar extractions. Often the miniscrews are placed according to the availability of safe zone, intraradicular clearance and type of mucosa. Sometime loosening and failure of miniscrew and reinserterion with change in site lead to asymmetry in positioning. This uneven positioning of miniscrew imposes unbalanced biomechanics in the same jaw. Force vectors of space closing auxiliary spring differs on both side and causes disturbance in occlusion or asymmetry in arch form. This article shows how ‘3D force vector indicator’ can be used to overcome the problems arise due to asymmetric retraction forces with miniscrew anchorage. This technique measures and specifies the correct location of implant head, i.e. 3D position of the posterior point of attachment for retraction auxiliary and its direction of vector with respect to the fixed appliance and the underlying dentition.

Keywords: Biomechanics, 3D force vector indicator, En masse retraction, Miniscrew anchorage, Retraction force.

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INTRODUCTION

Miniscrews are used as anchorage in orthodontics and have become an integral part in the orthodontic treatment of severely protrusive patients for maximum retraction of anterior teeth after premolar extractions. During insertion of miniscrew, emphasis is given on the host factors (safe zone), miniscrew dimensions, sterilization and biomechanical demand of directing the retraction force vector toward center of resistance of posterior teeth. In conventional sliding retraction (without miniscrew), importance to the arch form is indispensable and retraction forces are balanced posteriorly by the posterior teeth. But, with sliding mechanics which is most commonly followed with miniscrew retraction, forces are not balanced posteriorly by the posterior teeth but by the miniscrew. It causes certain idiopathic effects on the arch form. These biomechanical side effects occur in all the three-dimensions. Archwire suffers the external forces which tend to alter the arch form of the base wire. These effects are directly related to the magnitude and vectors of force. If miniscrews are not placed in the symmetrical and balanced position bilaterally in both arches, retraction force vector causes a disturbance in the original arch form coordination. Ignorance of uniformity/symmetry in positioning the miniscrew head in proper positions does create the asymmetry in the retraction forces and biomechanics in all three planes.

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This article illustrates how the ‘3D force vector indicator’ can be used to overcome the problems arise due to asymmetric retraction forces with miniscrew anchorage. This technique measures and specifies the correct location of implant head, i.e. 3D position of the posterior point of attachment for retraction auxiliary and its direction of vector with respect to the fixed appliance and the underlying dentition.

**Fabrication**

Weld the bases of two weldable round buccal tubes (length 5 mm) facing toward each other with their lumen oriented perpendicular to each other (Fig. 2A), this is known as the ‘connector’ (Fig. 2B). Insert the base archwire (0.018 round stainless steel) through the lumen of one of round tube of the four connectors. Another round tube of each connector will lie perpendicular to the base archwire. One pair of connector are adjusted to the molar section of base archwire and the other pair in the canine region bilaterally (Fig. 2C). A piece of brass wire (Fig. 2D) is passed through the lumen of the round tube which is perpendicular to the base archwire and known as ‘pointers’ (Fig. 2E). Round buccal tubes of 0.032” lumen should be slightly crimped, so that they have ‘semitight-fit’ when base archwire and brass wire used is inserted through them. Connector can be adjusted by sliding (in mesiodistal direction) or rotating (in buccopalatal direction) on the base archwire. Length of the brass wire can also be adjusted, so that it coordinates and denotes the exact location of the miniscrew head by posterior pointers and anterior hook by anterior pointers.
A 5 mm length of round tube can easily be adjusted to any inter-bracket span.

Components

1. Base archwire consists of pair of posterior and second pair of anterior pointers (Fig. 2E).
2. Posterior pointer shows the location of miniscrew head, where retraction ‘space closing spring’ is to be attached (Fig. 2E).
3. Anterior pointer shows the location of anterior hook between lateral incisor and canine (Fig. 2E).
4. Arch form template graph is used in selecting the shape of base archwire and evaluates discrepancies in the force vector (location of pointers) in three planes.
5. Goniometer** (one plane, uniaxial 14° transparent, plastic 180° or 360°).

Technique

1. Technique is performed usually before start of en masse retraction in each arch, where alignment and leveling is completed; miniscrews* are inserted and ready to load with retraction force auxiliary (Figs 3A to C).
2. Base archwire on which the two pairs of anterior and posterior pointers are rolled is adjusted in form, so that it matches to the patient’s selected arch form (Fig. 4).
3. Insert the base archwire into the molar tube and all slots of brackets, with adjusting the anterior pointers to simulate the position of anterior hooks between canine and lateral incisor and posterior pointers to denote the position of miniscrew head, i.e. posterior point of retraction auxiliary attachment (Figs 5A to C). Anterior connector positioned at interbracket span between lateral incisor and canine while posterior connector between 2nd premolar and 1st molar.
4. Gently take out the base archwire without disturbing the positions of the pointers and ready to evaluate it against the graph from all three planes. Retraction force vector is simply the straight distance between anterior and posterior pointers in each quadrant. This force vector is measured in sagittal, transverse and vertical planes, keeping base archwire against the graph.

- **Sagittal plane/lateral view (Figs 6A to C): With the help of goniometer,
  - Angle between retraction force vector and base archwire is measured bilaterally. Discrepancy between two sides shows the tendency to the asymmetric biomechanics.

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*1.5 mm diameter, 11.6 mm long, bracket head type (Aarhus Mini-Implant ScanOrto. Hans Edvard Teglers Vej 2, 29 20 Charlottenlund, Denmark, www.aarhus-mini-implant.com)
**Goniometer (Blundell Harling Ltd, 9 Albany Road, Granby Industrial Estate, Weymouth, Dorset, DT4, 9TH, Phone: +44(0)1305206000, www.blundellharling.com)
Fig. 4: Base archwire is adjusted in form so that it matches to the patient’s selected arch form.

Figs 5A to C: Maxillary ‘3D retraction force vector indicator’ in place. Posterior pointer records the 3D location of miniscrew head (posterior point of attachment of retraction auxiliary), anterior pointer record the 3D location of anterior hooks (anterior point of attachment of retraction auxiliary). After confirmation of all pointers it is gently taken out without disturbing the positions of pointers.

Figs 6A to E: Evaluation of symmetry in biomechanics: (A to C) Angle formed by the retraction force vector with base archwire or occlusal plane (shown by curved yellow arrow) and linear distance between two points of attachments (red line) of space closing auxiliary spring measured in sagittal plane with the help of goniometer. (D) Direction of retraction force vector measured in transverse plane and compared to contralateral side. (E) Distance of miniscrew head from base archwire measured in vertical plane.
• Distance between anterior and posterior pointers should be similar on bilateral sides of same arch; otherwise uneven stretch of auxiliary spring will create unequal forces.

B. Transverse plane/occlusal view (Fig. 6D): In case, if miniscrew and molars are not connected with a rigid wire, the retraction forces from miniscrews attempt to alter the arch form of base wire depending upon its vector direction.

- Too close placement of posterior pointer (miniscrew head) near base archwire shows the retraction force passing very closely to base archwire without changing the arch form
- Buccal placement of posterior pointer away from posterior base archwire: Retraction forces tend to create expansive effect in base archwire
- Lingual placement of posterior pointer inside posterior base archwire: Retraction forces tend to create constrictive effect in base archwire.

C. Vertical plane/front view (Fig. 6E):

- Unequal distances of miniscrew head from occlusal plane tend to change the angle of retraction force vector and asymmetric intrusion in anterior segment, causing canting of the occlusal plane.

DISCUSSION

Often the miniscrews are placed according to the availability of safe zone, interradicular clearance and type of mucosa.22 Sometime loosening and failure of miniscrew and reinsertion with change in site lead to asymmetry in positioning. This uneven positioning of miniscrew imposes unbalanced biomechanics in same jaw. Force vector of space closing auxiliary spring differs on both side and causes disturbance in occlusion or asymmetry in arch form.

Additionally, molar or posterior segment intrusion, and change in intermolar width have been observed as drawback of sliding (friction) method with miniscrew anchorage.21 These effects further get exaggerated with incorporation of reverse curve of Spee or compensatory curvature in lower or upper jaw respectively. Again the direction of retraction force is decisive in disturbing arch form. With this clinical aid, direction of retraction force is more efficiently evaluated in all three planes. This helps in planning the biomechanics according to the situation.

ADVANTAGES

‘3D force vector indicator’ provides better results with the following advantages:

- Helps in appropriate designing of biomechanics.
- For correcting the asymmetries, required adjustments can be done easily.
- It can also serve as guide for miniscrew placement which exactly shows the location of miniscrew head bilaterally in a single step.
- If same ‘3D force vector indicator’ is used before and after space closure, treatment changes occurred in the three-dimensions can be easily evaluated.
- Easy to fabricate chair-side and sterilize.
- It can be used for multiple patients by just adjusting the position of connectors and length, deflection of pointers.

REFERENCES


