Effectiveness of Asymmetric Headgear: A review

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Abstract

Asymmetric headgear is always a good option for the correction of the unilateral Class II dental relationships. Various asymmetric face-bows have been designed to produce unilateral molar movements. They have proved to be effective in producing an asymmetric distal force. But the undesired lateral force that tends to move the molars into cross-bite were unavoidable. Every face-bow effective in delivering unilateral distal forces will also deliver a net lateral force to the inner-bow terminals and the amount of lateral displacement is directly proportional to the asymmetry of the outer bow.

Key Words: Asymmetric headgear, lateral force, unilateral molar distalization

Introduction

Headgear was introduced to the dental profession by Norman William Kingsley in the 19th Century1 and various modifications have been made throughout time. Among them asymmetric headgear has been successfully used to correct unilateral class II relationship2-5. Though other treatment modalities which are independent of patient compliance like temporary skeletal anchorage devices (TADs) are available, asymmetric headgear continues to be used in many orthodontic practices6.

Many studies over few decades have demonstrated the effectiveness of asymmetric headgear modification theoretically2,3,7 and experimentally in vitro8-10 in delivering unilateral distal force. On the other hand, these same studies have reported that the development of posterior cross-bites arising from lateral forces is unavoidable. Various modifications of asymmetric headgear have been designed with the intent of increasing unilateral distal force while minimizing unwanted lateral forces8-11. But, the conclusion on effectiveness and side-effects are still inconsistent.

Types of asymmetric headgear

An asymmetric headgear consists of an outer bow, an inner bow, and a joint connecting them. There are marked differences in force system when altering the configuration of the outer or inner bows or the solder joint.

There are various types of unilateral face-bow designs available:

1. Power-arm face-bow

This design consists of dissimilar length of right/ left outer bow and diverse angulations between the outer and the inner bow with the longer or wider bow located on the side anticipated to receive the greater distal force. This is the most commonly used and the simplest and the effective type of face-bow7,8. Several studies8,9 have been done to evaluate the effectiveness of the power arm face bow and it has been well established that the power arm face bow is effective in delivering unilateral distal forces. But while being effective in producing unilateral distal forces, the power-arm face-bow also generates lateral forces.
Theoretical evaluation performed by Haack and Weinstein\(^2\) explained that the lateral forces on the two molars must be equal in magnitude and direction with the net lateral force directed from the heavy force side toward the light force side. This partially explains the result of lateral forces yielding lingual-buccal molar movement. However, this does not provide a theoretical explanation for the buccal-buccal movement observed in some studies\(^7,8\). Martina et al.\(^9\), Yoshida et al.\(^5\) also agreed that the lateral displacement occurs in the lingual direction on the heavy force side, and buccal direction on the light force side. And the amount of lateral displacement increases as the asymmetry of the outer bow is increased.

On the other hand, Nobel and Waters\(^7\), Hershey et al.\(^8\) reported that buccal displacements occurred on both molars. Hershey et al.\(^8\) explained that the lateral force was also directed buccally on the heavy force side because of the archial expansion effect of the inner bow. Nobel and Waters\(^7\) concluded that force systems are dependent on geometry of the bow and the increasing asymmetry of the outer bow is accompanied by the transference of the buccal force from the heavy force side to the light force side. That means, as long as the asymmetry of the outer bow is small, a buccal force acts on the molar on the heavy force side but as the asymmetry of the outer bow is increased, the amount of buccal force is decreased and finally shifted to the opposite side. Yoshida et al.\(^5\) confirmed this concept using human data, and Chi L et al.\(^6\) verified it with computer models using the theory of elasticity with the periodontal ligament as a linear spring.

With the power arm face-bows, distal rotation is another movement associated with distal movement\(^5,6,11\). However, the molar on the Class II side is frequently rotated more mesially than the opposite side and distal rotation is usually favored\(^5\). The distal rotation was found to be larger on the light force side than on the heavy force side and was observed to increase with the asymmetry of the outer bow\(^5,7\). If excessive distal rotation occurred on the light force side, an additional treatment with multibonded appliance may be necessary after headgear therapy\(^5\).

Fig.1. Power-arm face-bow

2. Swivel offset face-bow

Here the outer bow is connected with the inner bow through a swivel joint located in an offset position on the side where the greater distal force is desired.

Theoretically, the effect of a swivel offset face-bow can be determined by the location of the swivel joint\(^8\). But experimentally, the results obtained were different from the expected ones. When swivel offset face bow is fabricated so as to produce the same asymmetric effect as the power arm face-bow, the asymmetric effect and the lateral effect observed with the swivel offset face-bow were substantially larger than those of the power arm face-bow type\(^5\).

Baldini\(^3\), Nobel and Waters\(^7\), Hershey et al.\(^8\), have reported that lateral forces are developed unavoidably. But in contrast, Jacobson\(^12\) has demonstrated experimentally that the swivel offset face-bow provides the most satisfactory asymmetric force delivery without undesired lateral components.

Fig.2. Swivel-offset face-bow

3. Soldered-offset face-bow

In this design the outer bow is attached to the inner bow by a fixed soldered joint placed on the side anticipated to receive the greater distal force.
Haack and Weinstein² noted that the soldered offset face-bow is non-effective in delivering asymmetric distal forces. Hershey et al.⁸ also agreed that a soldered offset face-bow is not effective in delivering unilateral distal forces, nor will it deliver a net lateral force to its inner-bow terminals.

4. **Internal hinge face-bow**

It has hinge added mesial to the molar on the side not to be distalized and the external arm is also shortened on the same side.

The internal hinge face-bow has proved to be remarkably effective in achieving asymmetric distalization of the molars⁵,¹³,¹⁴. Sander¹⁰ experimentally analyzed the effect of an internal hinge face-bow and claimed that the internal hinge face-bow provides a more satisfactory unilateral force delivery by preventing the influence of asymmetric molar rotations.

In contrast to the other designs of face-bows, internal hinge face-bow shows lingual displacement of the molar on the light force side. It may be due to the effect of the internal hinge placed on that side which limits buccal expansion on that side⁵,¹³. But on the heavy force side, lingual displacement is more prominent than other face-bow designs¹⁰,¹³. So, the risk of development of posterior cross-bite is more on the heavy force side. Similarly, mesial rotation was also noted on the heavy force side⁵. Since the molar on the Class II side is frequently already rotated mesially, this movement is undesired.

5. **Spring-attachment face-bow**

It consists of open coil of spring distal to the stop of the inner-bow terminals of a conventional bilateral face-bow on the side favored to receive the greater distal force. This design of face-bow were found to be non-effective in delivering clinically significant unilateral distal forces⁸.

Theoretical analysis of asymmetric headgear:

Haack and Weinstein² derived a theoretical evaluation for orthodontic headgear mechanics few decades ago. According to him, when the tractional forces $F_L$ and $F_R$ is applied, they are equal in magnitude but because of the unequal arm length of the face-bow the direction of these forces is not symmetrical in relation to the midsagittal plane. The resultant force $F$ intersects and divides intermolar line into unequal distance $a$ and $b$. Then, the distal force component $FY$ is distributed to right and left molars in proportion to ratio of $a$ to $b$. Since the resultant force intersects the inter-molar line to the right of the midsagittal plane, the right inner-bow terminal ($F_{RY}$) receives a greater distal force than the left inner-bow terminal ($F_{LY}$). Now, the distribution of the distal forces can be determined as:

$$F_{RY} = FY$$
$$F_{LY} = FY$$

The magnitude of the net lateral force ($F_{XY}$) is theoretically determinable but the distribution of the lateral forces delivered to each inner-bow will be unpredictable and will be directed from the inner-bow terminal receiving the greater distal force toward the side receiving the lesser distal force⁸.
Limiting lateral force:

According to Yoshida et al.\textsuperscript{5} though the net lateral force on both molars cannot be changed, the distribution of the net distal and lateral force into individual molars can be changed by alterations in the configuration of the outer and inner bows. When the power arm face-bow is reversed, with longer or wider outer bow on the Class I side and shorter outer bow on Class II side, it produces a buccal force on the molar that should be more distalized and thus, preventing crossbite. Some authors\textsuperscript{5,15,16} have even suggested using transpalatal bar in association with headgear for avoiding excessive lateral forces. Distal toe-in bend can be added on the side of the palatal arch where molar distalization is not desired so that mesial force produced by palatal arch can counteract distal force generated by reversed power arm face-bow. Then equal and opposite distal forces are developed on the other end of the palatal arch with desired buccal force\textsuperscript{5}.

Studies on the effectiveness of asymmetric headgear

Hershey et al.\textsuperscript{8} evaluated five different designs of headgear including bilaterally symmetrical face-bow, soldered offset face-bow, spring attachment face-bow, swivel offset face-bow, and power arm face-bow. Their theoretical analysis was patterned after that of Haack and Weinstein\textsuperscript{2} and the results was compared to laboratory analysis. They reported that the power-arm and swivel-offset designs were effective at delivering unilateral distal force, and the bilateral symmetrical, spring attachment, and soldered-offset face-bows were not effective. Their conclusion indicated that the location of the face-bow joint had no effect in unilateral distalization.

Nobel and Waters\textsuperscript{7} checked the derived results of the theory experimentally and concluded that the force system is dependent on the geometry of the bow and the increasing asymmetry of the outer bow is accompanied by the transference of the buccal force from the heavy force side to the light force side.

Yoshida et al.\textsuperscript{5} tested three types of power arm face-bows, swivel offset face-bow, and internal hinge face-bow on human subject. Although all face-bow designs were effective in achieving asymmetric distalizations of the molars, they generated lateral displacements that may lead to an undesirable crossbite. They recommended the use of power-arm face-bow because it showed an acceptable asymmetric effect and is easily fabricated from a commercially available face-bow.

Chi L et al.\textsuperscript{6} used computer models to assess the influence of the periodontal ligament on the distribution of distal and lateral forces of asymmetric headgear. They concluded that the lateral forces delivered by asymmetric headgear are not equal, and the stiffness of the periodontal ligament affects the magnitude and direction of the resultant lateral forces. And the distal forces are determined by the periodontal ligament stiffness and the outer-arm asymmetry whereas the joint location and the inner-bow terminal length have negligible influence.

Brosh T et al.\textsuperscript{11} did experimental studies on 2 configurations: asymmetric outer bow and asymmetric inner bow and concluded that the longer bow terminal receives more distal force than the shorter bow. They recommended asymmetric outer-bow headgear for bilateral asymmetric Class II molar relationship and asymmetric inner-bow headgear for unilateral class II molar relationship.

Squeff LR et al.\textsuperscript{15} studied the effects of four different asymmetric headgear systems using simulated computer models. They compared the effectiveness of face bow with arms of different lengths, symmetric face-bow with one arm outward, symmetric face-bow with asymmetric transpalatal arch and face-bow with outer bow soldered to the inner bow. They...
found that, although all four systems were effective in asymmetric distalization of molars, the symmetrical face-bow with the outer bow soldered to the inner bow and symmetric face-bow used in combination with a transpalatal arch is the best. They also mentioned that undesirable lateral and occlusal displacing forces as well as tip-back and rotational movements were observed in all systems.

From the above studies it can be concluded that the asymmetric headgear are effective in delivering unilateral distalization of molars. Among various modification of the headgear, power –arm face-bow is the most effective design for delivering unilateral distal force. It is very simple in design and easy to fabricate. Though lateral displacing forces are unavoidable, it can be limited by altering the inner and outer bow configuration and also by using transpalatal bar along with headgear.

**Conclusion**

Asymmetric headgear is used when different distalization forces are needed on one side of the jaw than the other to correct a Class II molar relationship. It is effective in producing asymmetric distalization of molars; simultaneously undesirable lateral displacing forces are found which may lead to posterior crossbite. Lateral displacement is directly proportional to the asymmetry of the outer arch. That is, the more asymmetric the outer bow, the greater is the buccopalatal movement of the distalized molars.

**References**


