OVERVIEW

Passive and Active Overlay Systems

CARLALBERTA VERNA, DDS, PHD
S. TROIANI, DDS, MSC
C. LUZI, DDS
BIRTE MELSEN, DDS, DO

(Editor's Note: In this quarterly column, JCO provides a brief overview of a clinical topic of interest to orthodontists. Contributions and suggestions for future subjects are welcome.)

Fixed orthodontic biomechanical systems can be classified as statically determinate or statically indeterminate. In a statically determinate system, the archwire is inserted into the slot of only one bracket, where both moments and forces can act, while the other end of the wire is tied to one other unit, delivering only a force. The system can be described simply by the measurements of distance and force.[1-3]

A statically indeterminate system is characterized by the development of moments and forces with respect to two or more units—in other words, the archwire is inserted into two or more brackets. The force systems are determined by the mutual angulations of the slots, and thus undergo constant changes. Because estimating these force systems requires a series of calculations that are multiplied each time a tooth is added to the system, as described by Burstone and Koenig,[4] it is practically impossible for the clinician to predict the forces acting on individual teeth.[5]

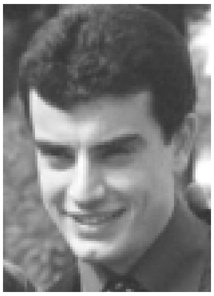
A continuous archwire system is simple to use and relatively comfortable for the patient, but it is statically indeterminate, since the wire is inserted into a series of brackets. The forces generated by the appliance and the forces resulting from function and the muscular matrices are therefore unpredictable. Although a continuous archwire can often produce satisfactory results, it can also generate unwanted side effects, especially in cases with significant individual tooth malalignments (Fig. 1).

A way to limit these side effects and thus improve the effectiveness of continuous archwire systems is to use two wires simultaneously. This approach is commonly referred to as an "overlay system". A stiffer wire, called the "master", is used to control the archform, and a highly elastic wire, called the "server", to deliver the forces needed for tooth alignment (Fig. 2).

Dr. Verna is an Associate Professor, Dr. Troiani is a Clinical Associate Professor, Dr. Luzi is a postgraduate resident, and Dr. Melsen is Professor and Head, Department of Orthodontics, Royal Dental College, Aarhus University, Vennelyst Boulevard 9, 8000-C Aarhus, Denmark. Dr. Melsen is also an Associate Editor of the *Journal of Clinical Orthodontics.* E-mail Dr. Verna at cverna@odont.au.dk.

Dr. Verna

Dr. Troiani



Dr. Luzi

Dr. Melsen

Fig. 1 Patient with severely displaced upper right canine. Use of continuous superelastic wire for leveling would have side effect of canting occlusal plane.

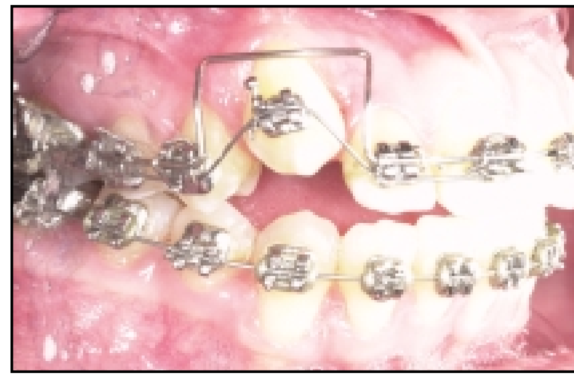


Fig. 2 Same patient treated with active overlay system for sagittal and transverse expansion. Use of .019" × .026" stainless steel master wire during canine leveling will prevent canting of occlusal plane.

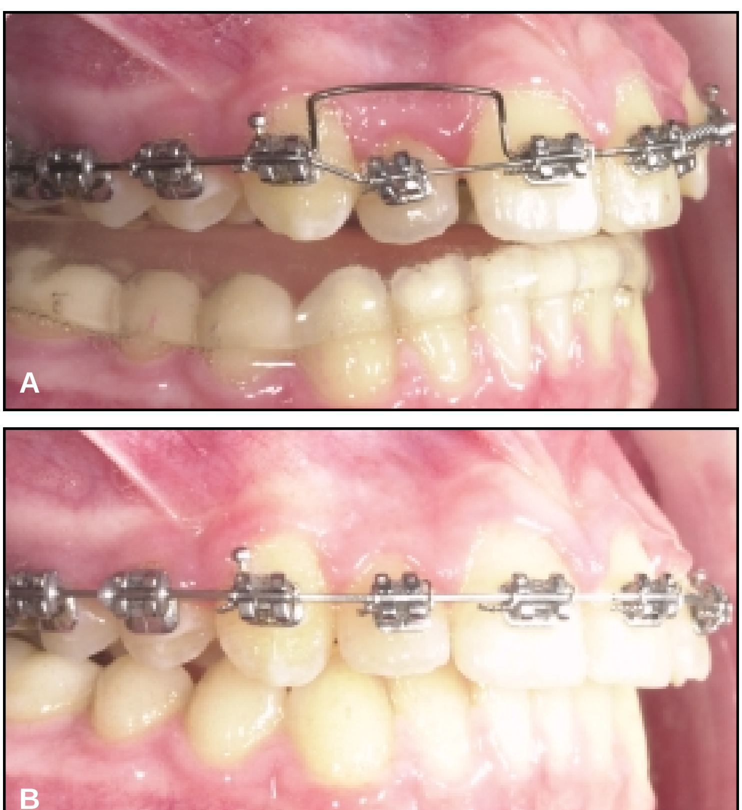
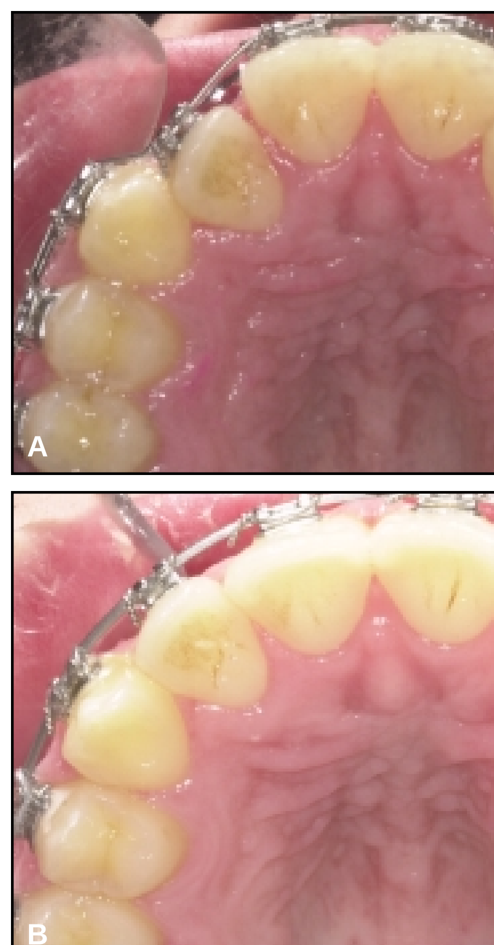


Fig. 3 Passive overlay system in case with sufficient space for alignment of upper right lateral incisor. A. .018" Australian master wire keeps already leveled teeth in place while .016" superelastic server wire aligns lateral incisor. B. Continuous archwire inserted after lateral incisor has been aligned.



Various kinds of overlay systems have been described, but a systematic classification has not yet been provided.[6,7] This article will describe the treatment possibilities offered by overlay systems and describe the approach used in the Department of Orthodontics at Aarhus University, Denmark.

Passive Overlay Systems

Overlay systems can be categorized according to the function of the master wire. In a passive system, the master wire is used only for anchorage, bypassing the teeth to be moved, while the server (an .014" or .016" superelastic wire) is used for 1st- and 2nd-order corrections of severely displaced teeth.

If enough space is available for the alignment of one or two teeth, a passive system is appropriate. A rectangular stainless steel or round Australian wire* is used as the master wire, with step bends bypassing the displaced teeth (Fig. 3). The server wire is inserted into the bracket slots on the malaligned teeth and then either tied to the master wire, as shown by Begg and Kesling,[8] or inserted into the slots of the adjacent brackets, beneath the master wire, as recommended by Hilgers.[9] It should be noted that if the master wire is tied directly to the server, it will produce a V-bend effect on the server wire.[4]

*G&H Wire Company, P.O. Box 248, Greenwood, IN 46142.

Active Overlay Systems

In an active overlay system, the master wire is used to deliver additional sagittal or transverse forces, while the server wire is used for alignment. The directions of the forces delivered by the master wire are determined by its configuration.[10]

If there is insufficient space available for the alignment of displaced teeth, the master wire's bypass bend should be slightly longer than the interbracket distance between the two teeth adjacent to the malaligned teeth (Fig. 4). Thus, the master wire will generate space while the server wire brings the teeth into their correct positions. An alternative is to place open-coil springs on the master wire[6] (Fig. 5). This method generates friction, however, and the presence of the springs may prevent complete alignment of the displaced teeth.

Both passive and active overlay systems can

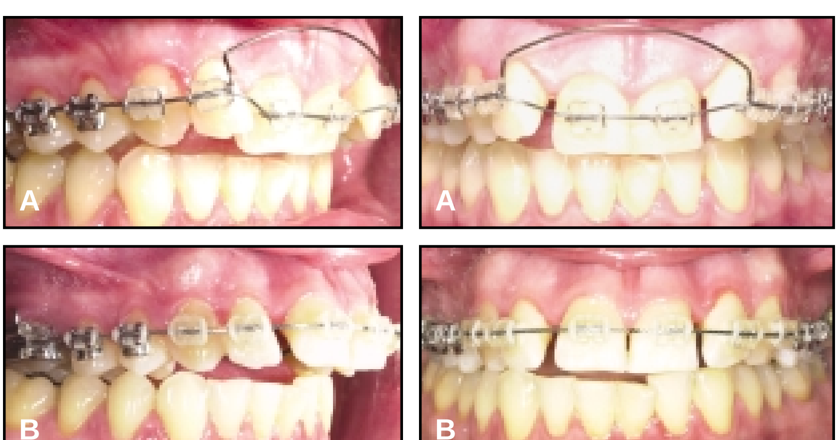


Fig. 4 Active overlay system used to provide space for leveling proclined upper central incisors. A. .018" Australian master wire configured with bypass bend 1mm longer than interbracket distance. B. Continuous archwire inserted after central incisors have been proclined.

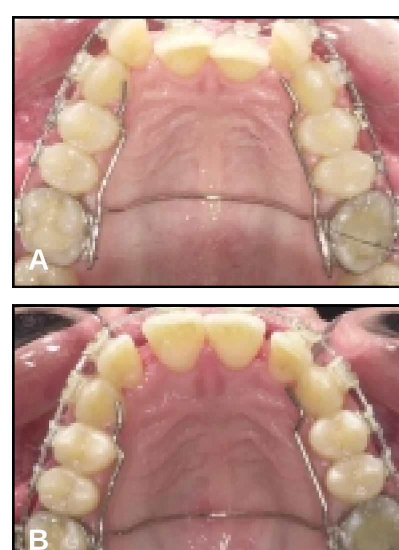


Fig. 5 Open-coil spring provides space for 1st-order alignment of lingually displaced second premolar with .016" superelastic server wire and .018" Australian master wire.

Fig. 6 In self-ligating bracket system, server wire is tied to brackets with additional ligatures.

be applied to self-ligating brackets (Fig. 6).

Conclusion

Overlay systems are not as predictable as the statically determinate biomechanical systems typical of the segmented-arch technique. Nevertheless, they are effective in preventing the undesirable side effects that can result from the use of continuous archwires. In selected cases, they represent a valid alternative to more complex biomechanical systems.

REFERENCES

1. Choy, K.; Pae, E.K.; Kim, K.H.; Park, Y.C.; and Burstone, C.J.: Controlled space closure with a statically determinate retraction system, Angle Orthod. 72:191-198, 2002.
2. Fiorelli, G. and Melsen, B.: *Biomechanics in Orthodontics*, CD-ROM, Libra Ortodonzia, Arezzo, Italy, 2001.
3. Melsen, B. and Fiorelli, G.: Biomechanics: Computer-based mechanotherapy, J. Clin. Orthod. 28:136-141, 1994.
4. Burstone, C.J. and Koenig, H.A.: Creative wire bending—the force system from step and V bends, Am. J. Orthod. 93:59-67, 1988.
5. Burstone, C.J.: Rationale of the segmented arch, Am. J. Orthod. 48:805-822, 1962.
6. Sandler, P.J.; Murray, A.M.; and Di Biase, D.: Piggyback archwires, Clin. Orthod. Res. 2:99-104, 1999.
7. Cureton, S.L.: The "over and under" overlay wire, J. Clin. Orthod. 29:263-266, 1995.
8. Begg, P.R. and Kesling, P.C.: *Begg Orthodontic Theory and Technique*, 3rd ed., W.B. Saunders Company, Philadelphia, 1977.
9. Hilgers, J.J.: Bioprogressive simplified: Part 3: Nonextraction therapy, J. Clin. Orthod. 21:794-804, 1987.
10. Dalstra, M. and Melsen, B.: Force systems developed by six different cantilever configurations, Clin. Orthod. Res. 2:3-9, 1999.