

# APPLICATION OF VERTICAL BRACKETS IN ORTHODONTIAL TREATMENTS: A LASER SPECKLE STUDY.

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# APPLICATION OF VERTICAL BRACKETS IN ORTHODONTIAL TREATMENTS: A LASER SPECKLE STUDY

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## 1. Introduction

This paper reports the application of a laser speckle technique for orthodontial studies. The purpose of these studies is to certify the validity of a proposal related with a new type of apparatus, and the methodology to be used in orthodontial treatments.

As it is well known, man evolution shows a reduction in maxilla size. Such reduction can be observed by comparing the size of maxillas with the size and distribution of teeth, in some members of the filum that, hypothetically, was initiated in the final period of the Third Era, and continued up to the man of present times.

In Figure 1 a) it is compared the maxillas of chimpanzees, gorillas, orangoutangs, and men. As one can see, the number of teeth is the same in the four cases, but their sizes and distributions are different, depending upon food regimen, and in the case of men, it is very important to add, upon its cultural behaviour. Besides, Figure 1 b) emphasises the comparison of teeth profiles between gorillas and men. Gorillas and other primates have prominent canines, and their diastemas are fit for providing the best occlusion for mastication. Such prominent canines play an important role for their strong, hard, and dry mastication. In the fossil rests of all the primitive men we know, as those of the "Pithecanthropus Erectus", the size and position of canines are almost the same as in maxillas of present times, as shown in Figure 1 c). However, their teeth were stronger than ours, to provide for a mastication like that of primates. It produced a permanent horizontal and vertical migration of teeth, so preventing caries and periodontal illness and, at the same time, the muscular excercises contributed to the growth of maxillas.

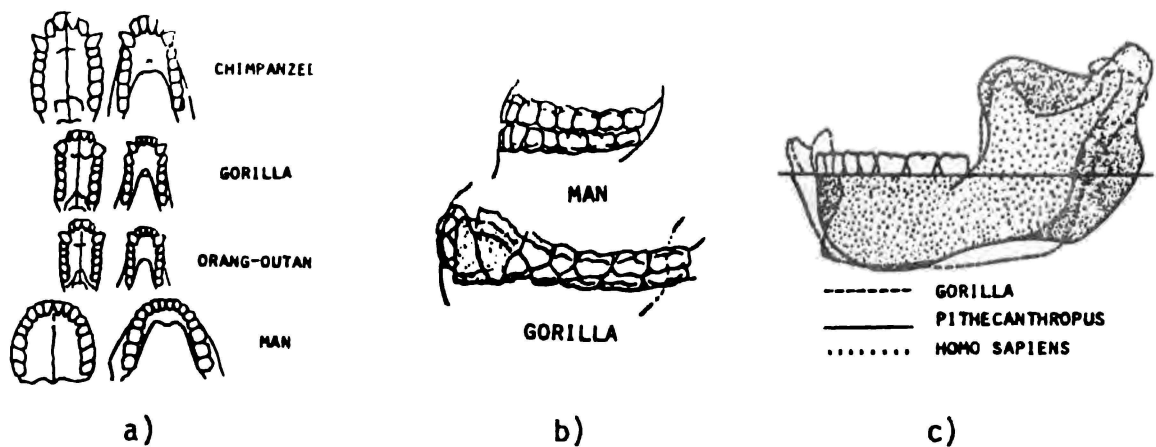


Figure 1. Comparison of maxillas and distribution and profiles of teeth in man and primates.

The soft alimentation of men, which appeared with cooking and, afterwards, with the use of fork and knife—that is, with human civilization—produced a reduction of those muscular movements, starting an involutive process of maxillas. This process was also accelerated by the diminution of the suckling period of babies. These are the main arguments to justify that at least a 40% of patients between 10 and 15 years old suffer from markedly discrepancies between the distribution of clustered teeth and the size of maxillas.

## 2. Orthodontic apparatus and techniques. Proposed modifications: Vertical brackets versus horizontal brackets.

Figure 2 shows a clear example of the situation represented by the patient case N° 88. Its part a) is a living and impressive picture of the mouth of a girl 12 years old, while part b) is a gypsum model made at the initial state of the treatment, showing malocclusion, and part c) is a view of the occlusal plane of both maxillas.

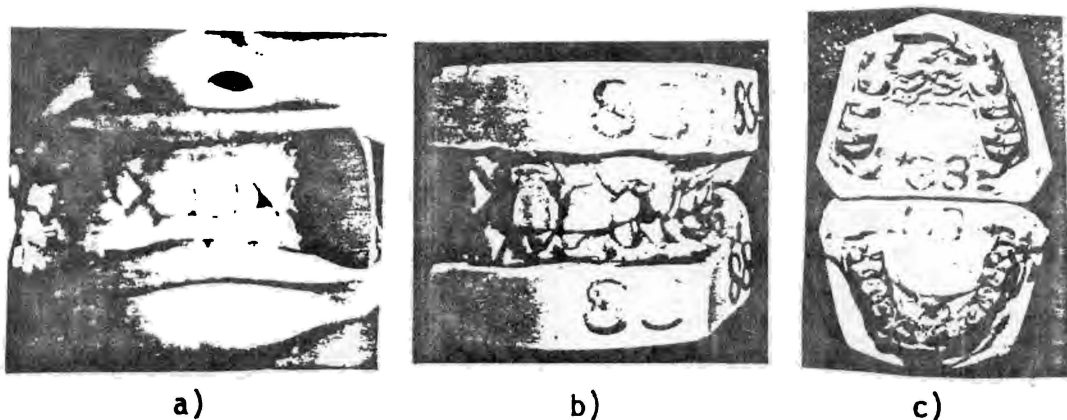


Figure 2. Initial state of the treatment of patient N° 88.

This kind of malocclusions can be orthodontically treated by using several clinical techniques which, in general, follow the basic principles stated by Edward Angle in 1928 [2]. The pioneering technique developed by

Angle is based on the bracket edgewise appliance, properly cemented to teeth, which serve for applying forces or couples to them. They are applied by using stainless steel arch wires or rubber bands, as it is shown in Figure 3 b). All techniques developed until now employed horizontal brackets cemented to teeth, and as a result of the application of forces in a point of teeth crowns, their roots pivot on gingival and apical fulcrums, producing rotations of the entire dental piece around an axis located somewhere between, as shows Figure 3, a). Then, the employment of horizontal brackets produces a combination of rotations and translations of teeth.

Using horizontal brackets, the position of the crowns at the end of treatment can be good from the aesthetic point of view, but the radiologic-al study shows anomalies in root orientation, as observed in Figure 3 c). This is the origin of serious damage of the masticatory function and of periodontal illness.

To solve these questions, it were introduced a new type of brackets and various modifications in well known apparatus, as in the Mershon arch. The most important innovation is the development of the technique that uses vertical brackets instead of the horizontal ones. This technique is called distal-corrector action technique employing combined gentle forces [2].

By using vertical brackets it is possible to charge the crown with a system of forces whose resultant is applied in a appropriate point, as it is shown in Figure 3 d), to produce the displacement of teeth parallel to themselves.

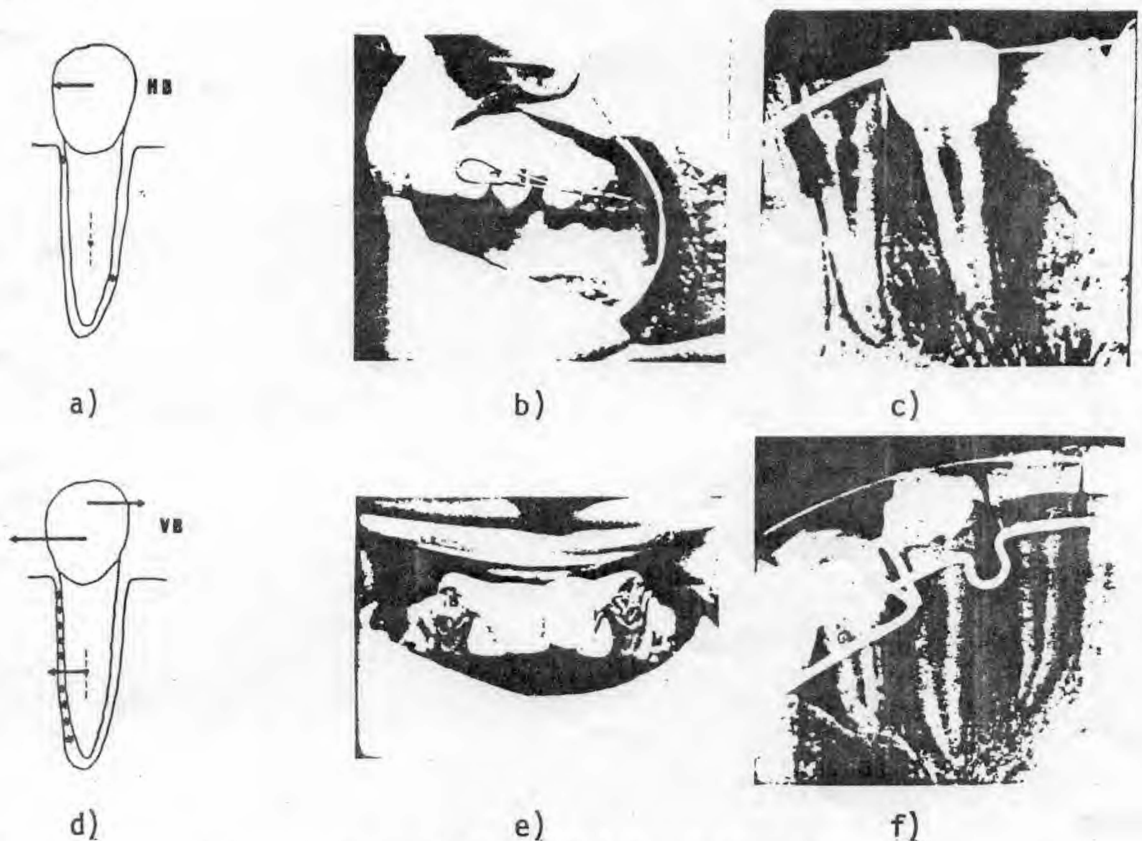


Figure 3. Vertical brackets vs. horizontal brackets.

Figure 3 e) shows a clinical case with vertical brackets applied in the upper canines. This kind of vertical brackets are recommended to be applied in those clinical cases where dental pieces must be moved parallel to themselves, to their right places, or to produce a careful treatment finishing, with a good occlusion.

As we said before, vertical brackets allow orthodontists to apply to the crown a system of forces instead of a force in a point. Furthermore, it is possible to give to vertical brackets the proper angle of orientation, and to associate another type of forces as shown in Figure 3 e). In this case, the vertical bracket applied to the upper canines is  $10^\circ$  from its axis, to compensate the influence of the second incisor, and in addition, an extrusion force will be applied on it, to pull it down to the occlusal plane.

### 3. Laser speckle measurements.

A Type-0-Dont simulator was employed for modelling the physical situation of the mouth to prove that the action of vertical brackets produces movements of teeth that are perpendicular to the axis of their roots. In the same laboratory simulator was also modelled the action of horizontal brackets. Then, the results obtained serve to compare both techniques. Figure 4 a) shows details of the simulator. Observations were devoted to both canines and to the second premolar. The Merston arch was modified, and its end was turned out around the mesial face of the second premolar, to prevent its mesioversion, as it is shown in Figure 4 b). The first premolar was extracted.



Figure 4. Type-0-Dont laboratory simulator for modelling the action of vertical brackets.

Laser speckle interferometry was employed for measuring the movements in artificial teeth. Two simultaneous perpendicular planes of observation were illuminated with an ion argon laser at 514.5 nm wavelength and 1 watt power. One of them was the occlusal plane, and the other was a tangential plane to the dental arch in the canine position. As it is known, specklegraphy can be used for measuring the magnitude and angular orientation of small movements, but not the sign of the displacement vector. In the experiments we performed, signs were defined according with physical considerations. In order to obtain better resolution, it was used holographic film for recording double exposure specklegrams. The first pair of perpendicular

exposures was photographed with the dental system unloaded. After that, forces were applied to the model, following the orthodontial fashion, and the second pair of perpendicular exposures was then photographed. In order to apply the appropriate set of forces with well defined angular orientation and intensity, an adequate stainless steel arch wire was developed, which is shown in Figure 5.

Magnitude and angular orientation of dental displacements were electronically determined by illuminating the specklegrams with 2 mW power 632.8 nm wavelength He-Ne laser.

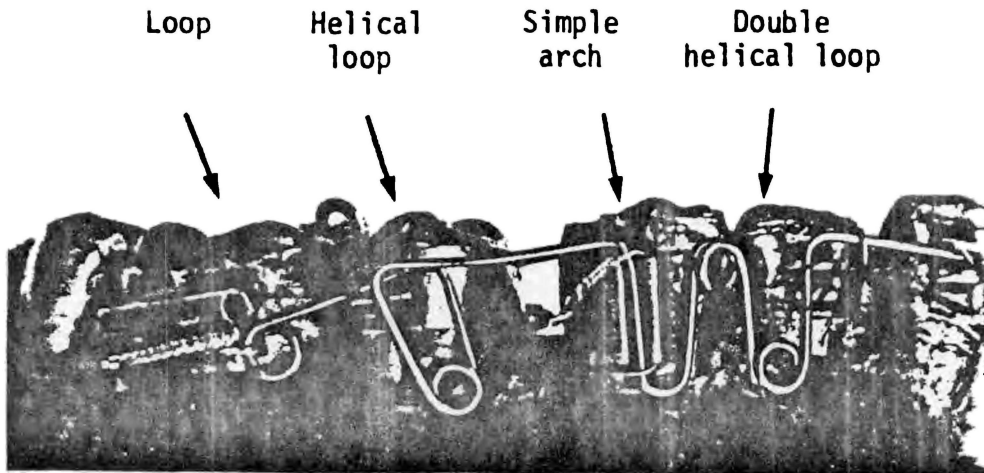


Figure 5. Arch wire employed with vertical brackets

A summary of the results with the movements of canines produced by the action of vertical and horizontal brackets is shown in Figure 6. We can

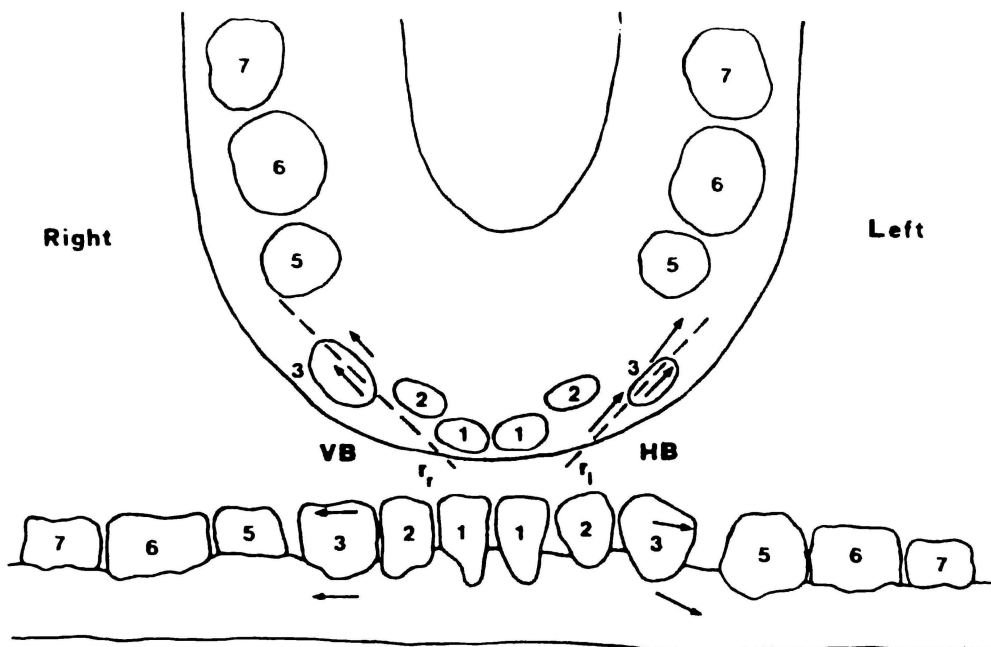


Figure 6. Displacement vectors determined by laser speckle interferometry in the cases of horizontal (HB) and vertical brackets (VB).

observe that the displacement of canines and surrounding gum of them appeared to be parallel to the respective dental arch tangent, if one observes the actions of the vertical and horizontal brackets in the occlusal plane. But, if observations are made in the planes tangent to dental archs, a pure translation is measured in the case of vertical brackets, and a combined roto-translation in the case of horizontal brackets.

Figure 7 shows a summary of quantitative results of one of our experiments. They confirm what we said before related with the aesthetic point of view in crown positioning. If we observe the lines of forces and the displacement in the occlusal plane, the results are almost the same for both cases, that is, by using horizontal brackets as well as vertical brackets. But, attending to the efficiency of the masticatory function, orthodontical results obtained with vertical brackets are incomparable better than those obtained with horizontal brackets, as we can corroborate by radiological examination of clinical cases. Figure 3 f) is a reproduction of a clinical case radiography at the final stage of treatment.

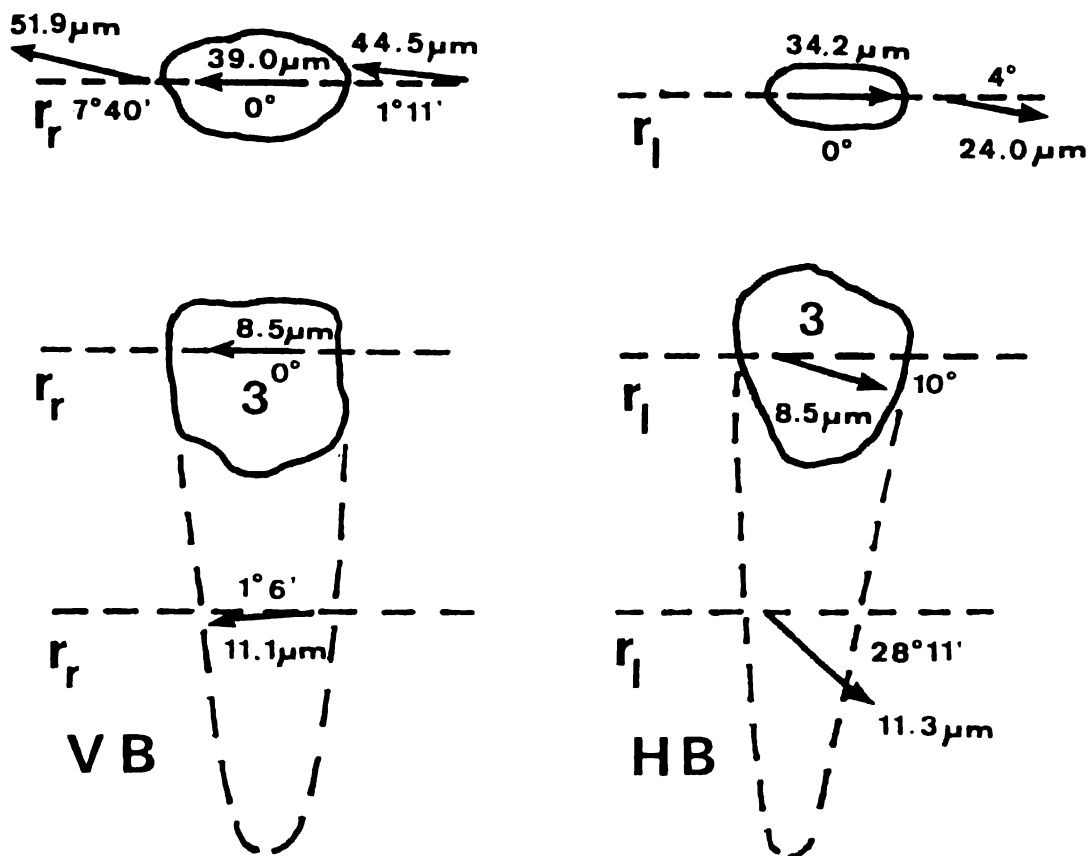


Figure 7. Quantitative results from laser speckle interferometry in the cases of horizontal (HB) and vertical brackets (VB).

It is clearly observed the degree of parallelism obtained between roots of incisors, canines, and premolar. Besides, Figure 8 shows the gypsum model of the clinical case N° 88 at the end of the successful orthodontic treatment.





Figure 8. Gypsum model at the final stage of the treatment of clinical case N° 88.

#### 4. Conclusions.

In conclusion, our opinion about the advantages of the use of vertical brackets instead of horizontal brackets, for those clinical cases where it can be recommended such orthodontial technique, is justified by the results of optical experiments, clinical treatment, and radiological studies. These results are good enough from functional, aesthetical, and psychological point of view. Besides, the metallic elements and components to be employed in the vertical brackets appliance are the same than those the orthodontist uses in applying the previous techniques. Then our proposal is not expensive or, at least, not much more than previous techniques. The time of treatment with vertical brackets is comparatively equal or even shorter than that with horizontal brackets.

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