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PERSONIFIED APPROACH TO SELECTING A METHOD FOR BRACKET POSITIONING WITH 3D TECHNOLOGY

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ABSTRACT — The concept of creating the so-called esthetic smile is still subject to debate. While there is no optimal way to achieve the smile esthetics, this fact drove the idea of improving the available algorithms employed for the treatment of dentofacial anomalies. Smile reconstruction in orthodontic treatment is a complex process, which is subject to certain rules and laws, and takes an interdisciplinary approach from dental specialists. When dealing with dental anomalies, one of the most important practical components is the correct method of the bracket positioning. Based on the analysis of the options offered currently by digital technologies, and the negative outcomes of orthodontic treatment, the following aim was set for the current study – to improve the algorithms employed to select individual methods of bracket personalized placement as per each clinical situation in particular. The methods used through the study included: clinical, digital, statistical, and analytical one. Following the criteria of the esthetic smile, the location, the shape and the structure of the teeth of a particular patient, an individual method for bracket positioning was developed, the final outcomes of that being a smile with individual parameters. This method allows achieving a maximum esthetic result. The proposed technique is the method of choice in each specific clinical situation and can be used depending on the indications.

KEYWORDS — brace, 3d-technology, positioning, dentofacial anomalies.

INTRODUCTION

High prevalence of malocclusion, related complications through treatment [1-6], improperly fixed brackets [7], imperfect equipment [8], as well as inefficient conventional methods used to position brackets — all these explain the search for newer ways to treat dentofacial anomalies. The core of orthodontic treatment is the tooth movement caused by various forces. The magnitude and direction of the force depends on the device design and on the mode it uses, which is opted for by the doctor. Employing the Edgewise technique for treating patients with abnormal shape and size of dental arches, the orthodontist determines the treatment methods, the brackets specification as well as the size of the metal arch [9–12].

Nowadays, apart from solving problems of function, Orthodontics pays great attention to esthetics [13], whereas an esthetically appropriate outcome is not always achievable in this area. Offering a rational set of treatment to patients with occlusive disorders associated with dentition defects is an important problem within interdisciplinary dentistry [14, 15]. The basic role for an effective treatment outcome lies in a personalized approach and an individualized choice of the braces positioning method, thus aiming at reconstructing the smile [16–19]. The final outcome visualization done through virtual positioning of braces will allow evaluating its effectiveness as well as making sure that the method selected for the brace positioning in a specific clinical situation was the right one, even prior to fixing the brace system.

Aim of study:

to improve the algorithms for selecting individual methods of personalized bracket positioning in each clinical situation.

MATERIALS AND METHODS

The dental anomalies were studied at the Dentistry Department, Faculty of Postgraduate Training of the Privolzhsky Research Medical University (Nizhny Novgorod, Russia). The study involved 15 patients of both sexes aged 11 to 20 with dental anomalies. A signed consent was obtained from each patient agreeing voluntarily to join the study as well as to follow the proposed treatment plan.

Materials

1. Digital models of jaws.
2. Maestro 3D Ortho Studio software.
3. Bracket positioning methodology by MBT, Pitts, Alexander.
4. Esthetic smile evaluation criteria.

Methods

1. Clinical.
2. Digital.

3. Analytical.
4. Statistical.

RESULTS

Here below we are offering a clinical case presentation in order to disclose the algorithm developed for arriving at an effective esthetic outcome.

Patient K., 11 y.o.; diagnosis: distal bite (07.20)

1. Clinical stage

Visual examination: the face configuration — not changed; skin — clean, with no visible pathological changes; mouth opening — unobstructed; TMJ — normal.

Oral cavity examination: the lateral part features closure of the molars on the right and left (Class II by Angle); V-shaped upper dental arch; trapezoidal lower dental arch; the sagittal gap within 4 mm; the upper central incisors overlap the lower ones by more than 2/3; diastema observed; oral mucosa — pale pink, moderately wet.

Photoprotocol (Fig. 1).

Model analysis (Fig. 2).

X-ray examination (Fig. 3)

McLaughlin telerentgenogram calculation (using the Onix Ceph software) (Fig. 4).

Diagnosis set based on the clinical examination data: distal bite (K07.20).

The conventional treatment method implies the installation of a bracket system subject to one of the three standard methods, each of them being failing to prove perfect and, therefore, featuring both its own advantages and disadvantages.

2. Digital stag

3D scans of the patient's jaw models were obtained with a 3D-scanner, the entire procedure performed in the Laboratory for Additive Technologies of Privolzhsky Research Medical University (Fig. 5).

To select the optimal treatment method and improve the previously approved algorithms, virtual positioning of brackets was done according to the three standard methods (MBT, Pitts, Alexander) with the Maestro 3D Ortho Studio software (Fig. 6).

Each of the positioning techniques featured its own height of the brackets on the teeth. Depending on the bracket location, the teeth could move to differ-

Fig. 1. *Photoprotocol of the oral cavity, patient K. 11 years old*

Fig. 2. *Models of the patient's jaws*

Table. 1. *Biometric study of jaws diagnostic models*

Index before treatment:	Result before treatment:	Norm:
Pont	upper jaw: premolar – 33.5 molar – 46 lower jaw: premolar – 32 molar – 41.5	premolar – 35 molar – 43.75
Tonn	1,55	1,33
Bolton	For 12 teeth: 87.6% For 6 teeth: 74.4%	For 12 teeth: 91.3% For 6 teeth: 77.2%
Deficiency of space in the dentition	Upper jaw: 4mm Lower jaw: 4mm	Upper jaw: 0 Lower jaw: 0

Fig. 3 *Orthopantomogram and teleroentgenogram of patient K., 11 years old*

variable	description	norm value	value	difference	deviation	verbal
SNA	SNA angle	82,0±3,5°	82,4°	0,0		
SNB	SNB angle	80,0±3°	75,5°	-1,5		
ANB	ANB angle	2,0±2,4°	6,9°	+2,5		
A / NP	distance of A-point to Nasion perpendicular	0,0±3,1mm	0,4mm	0,0		
Po / NP	distance of Pogonion to Nasion perpendicular	-4,0±5,3mm	-14,8mm	-5,5		
WITS	distance of A and B on occlusal plane	0,0±1mm	13,0mm	+12,0		
SN / MP	angle between S-N and mandibular plane	32,0±5°	35,7°	0,0		
FH / MP	angle between FH and mandibular plane	26,0±5°	27,9°	0,0		
PP / MP	angle between palatal and mandibular plane	28,0±5°	30,9°	0,0		
PP / OP	angle between palatal and occlusal plane	10,0±4°	9,8°	0,0		
MP / OP	angle between mandibular and occlusal plane	17,4±5°	21,1°	0,0		
U1 / A Po	angle between axis of U1 and A-Po	6,0±2,2mm	17,0mm	+8,8		
L1 / A Po	angle between axis of L1 and A-Po	2,0±2,3mm	-6,1mm	-5,8		
U1 / PP	angle between axis of U1 and palatal plane	110,0±5°	118,1°	+3,1		
L1 / MP	angle between axis of L1 and mandibular plane	95,0±7°	87,9°	-0,1		
U1 / OP	angle between axis of U1 and occlusal plane	57,3±7°	52,1°	0,0		
L1 / OP	angle between axis of L1 and occlusal plane	72,0±5°	71,0°	0,0		

Fig. 4. *Calculation of McLaughlin teleroentgenogram using Onix Ceph software*

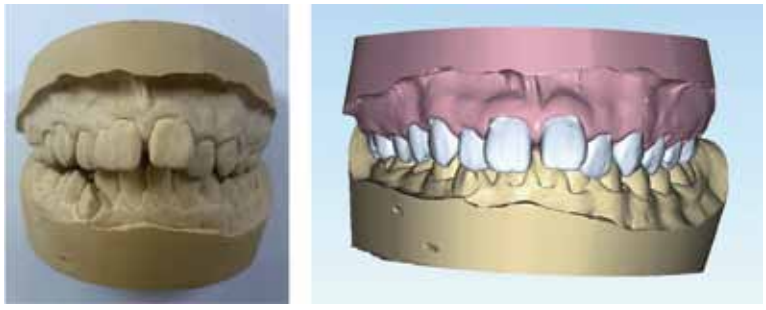

Fig. 5. *Plaster (a) and virtual (b) diagnostic models of the patient's jaws*

ent positions. Further, the teeth virtual movement based on specified parameters was performed automatically, whereas the final result of the planned treatment was visualized on the PC (Fig. 7).

The results obtained were evaluated in terms of meeting the aesthetic smile criteria (Table 2). None of the methods met the esthetic smile criteria, so, based on those, virtual positioning of the brackets was performed according to the individually developed method (Fig.8), following the analysis of standardized methods for bracket placement.

Next, the teeth virtual movement with the specified parameters was also carried out automatically, with the final result visualized (Fig. 9).

3. Analytical stage — matching the obtained smile against the esthetic smile criteria (Table 3).

Apart from the esthetic parameters, the individual method for bracket positioning was employed to model the orthognathic bite for the patients, which facilitates complete functions of speech, swallowing and chewing. No supercontact was observed in any of the occlusions.

CONCLUSION

Based on the study outcomes, we may conclude that creating the esthetic smile and improving the function requires planning the treatment outcome through building a 3D-model as well as selecting optimal bracket positioning following an individual method. The final outcome is the best-balanced smile and orthognathic bite.

Therefore, the treatment algorithm with individual bracket positioning has accomplished the smile maximally matching the criteria of an esthetic smile.

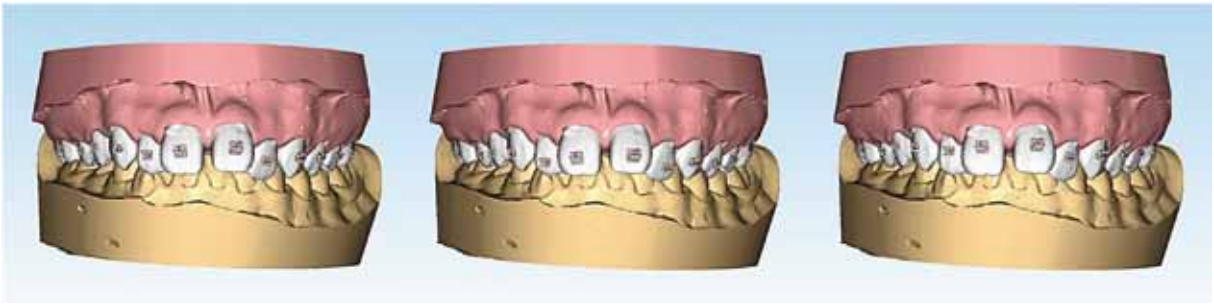

Fig. 6. Virtual positioning of brackets using three standard techniques MBT, Pitts, Alexander

Fig. 7. Virtual movement of teeth with specified parameters when positioning brackets according to standard techniques

Table. 2. Comparative characteristics of the criteria for esthetic smile and the parameters of the received smile options with standard methods of bracket positioning

Criteria	Positioning by MBT	Positioning by Alexander	Pitts positioning
Length of central and lateral incisors	-	+	-
Location of zeniths	-	-	-
Condition of the gums and interdental spaces	+	+	+
Axes of teeth	+	+	+
Interdental contact areas and points	+	+	+
Gaps between cutting edges	+	+	+
Individual and total sizes of teeth	+	+	+
Teeth proportions	+	+	+
Shape, color and micro-relief of teeth	+	+	+
Teeth position	+	-	-
Smile line	+	-	-
Upper and lower lip lines	+	-	-

The proposed method offers the following advantages:

1. Virtual bracket placement at the stage of treatment planning aimed at a predictable outcome.
2. Lower level of error due to the teeth movement 3D modeling.
3. Evaluation of the expected smile prior to the treatment and fixing the brackets.
4. Possible development of a key for bracket placement in the patient's mouth.

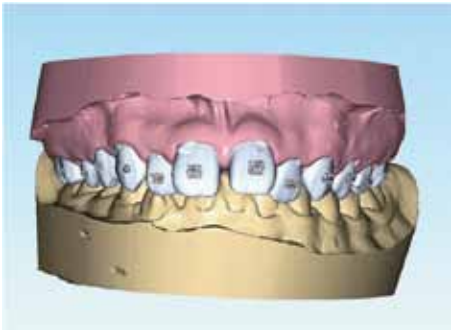

Fig. 8. Virtual positioning of braces according to an individual technique

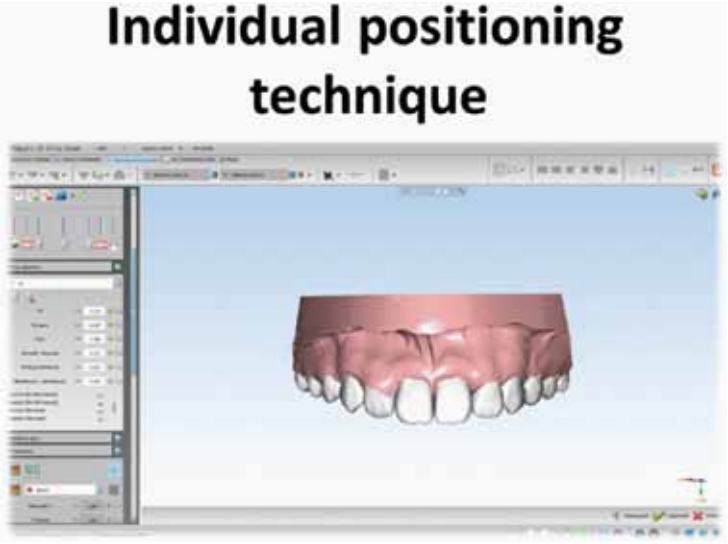

Fig. 9. Virtual movement of teeth with preset parameters when positioning brackets according to an individual technique

Table 3. Comparative characteristics of the criteria for an aesthetic smile and the parameters of the received variants of a smile with an individual technique for installing brackets

Criteria	Individual positioning
Length of central and lateral incisors	+
Location of zeniths	+
Condition of the gums and interdental spaces	+
Axes of teeth	+
Interdental contact areas and points	+
Gaps between cutting edges	+
Individual and total sizes of teeth	+
Teeth proportions	+
Shape, color and micro-relief of teeth	+
Teeth position	+
Smile line	+
Upper and lower lip lines	+

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