

COMPARATIVE STUDY OF MATERIALS AND TECHNOLOGIES IN ORTHODONTICS⁸

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Abstract: *The report systematizes the materials and technologies for diagnosis and treatment of occlusion in dentistry. Prospective digital technologies for expert diagnosis of orthodontic condition in patients are considered. It has been shown that any medical dental action affects the whole body, for example temporomandibular joint dysfunction (TMJ) can cause a problem in another part of the body. The synergy of engineering and medical approaches in this field of science is very important to achieve significant results.*

Keywords: Materials in dentistry, Orthodontics

INTRODUCTION

Orthodontics is a young but a fast growing medical specialty which expertise includes occlusal anomalies and problems in the muscular-skeletal system, which may have occurred due to pathological dental contacts [1-4]. The multidisciplinary medical discipline that researches these problems is called Posturology. It involves specialists such as orthodontists, ophthalmologists, neurologists and physical therapists.

The goal of the orthodontic treatment is more than fixing deformities. It is a possibility for prophylaxis and change in the pathological maxilla-facial growth processes.

Posturology studies human posture (the neuro-muscular-skeletal system keeping our bodies upright.) Specialists in this field recently proved that solving occlusal, temporomandibular joint (TMJ) and jaw issues we can prevent skeletal deformities, periodontal pathological processes, esthetic and phonetic problems.

EXPOSITION

1. Measuring occlusion digitally

The term “occlusion” refer as upper and lower teeth making contact. In other words - the bite. Dentists use T-scan (Fig. 1) to analyze the bite on the first appointment. The apparatus could visualizes the destructive forces before they become a problem causing dental fractures and joint pain. T-scan simultaneously shows the real measured forces in every contact point, as well as the first contact (normally in the posterior region). The real time in mm/sec of full dental contact (irregular contact needs more muscle force, which adds to unwanted muscle volume) could also be determined. With T-scan the need of proper treatment could be provided more easily, compared with the use of articulating paper.

⁸ Докладът е представен на научната конференция на РУ и СУ 2021 с оригинално заглавие на български език: „Сравнително изследване на ортодонтични материали и технологии“



Fig.1 T-scan equipment

Depending on the degree of severity and reasons for occlusal problems, the treatment could be limited to changing fillings or to full rehabilitation. Orthodontic treatment can be either conducted independently or alternatively combined with prosthodontics.

Another reason for malocclusion are malposition of teeth and jaws. Tooth rotation is an orthodontic anomaly which causes malocclusion and overload of other tooth/teeth which may also rotate or consequently change the position in order to avoid the load.

Thus the new digital analysis technology takes us to a higher level in prosthodontic and dental treatment which provides security and confidence during meals.

The modern digital apparatus used in dentistry for studying the occlusion represent the process of “bite” in “time-force” diagrams (Fig. 2). In this diagrams we obtain information regarding the level of forces induced on the teeth and the time they occur. The information is represented in color graphs: (i) Black line - changes in the general force during process of scanning; (ii) Red line - changes in the force on the right side during the overall scanning; Green line - changes in the force on the left side during scanning.

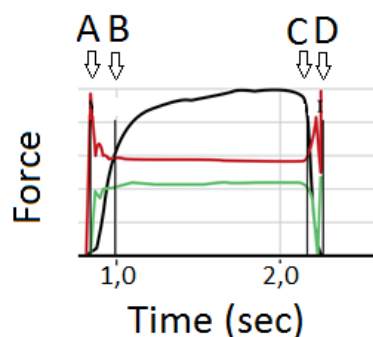


Fig. 2 “Time-force” diagram of an occlusion with specific time points: A - first occlusal contact; B - static inter-cuspation; C - excursion beginning ; D - full bilateral disocclusion, incl. first premolar.

The diagram on Fig. 3 represents an example of a diagram representing four human “bites” during a real patient examination used to balance the occlusion during correction. The distance between the red and green line shows the quality of the occlusal balance. The digital scanners could give a 3D representation of the force distribution as shown on Fig. 4.

Another important aspect of more precise study of the occlusion [5-9] is the correlation between TMJ and jaw issues and some skeletal deformities illustrated in Fig. 5, a. Solving the above dentistry issues, prevents skeletal deformities, periodontal pathological processes, esthetic and phonetic problems. Evaluating a scanned image helps to find the best bite and identifying the strongest potentially dangerous teeth contacts (Fig. 5, b).

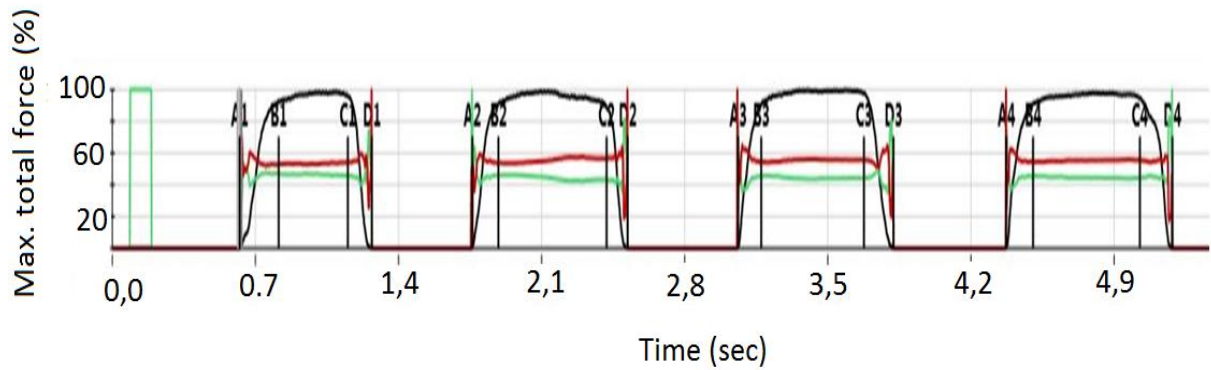


Fig. 3 A real example of “time-force” diagram representing human occlusion.

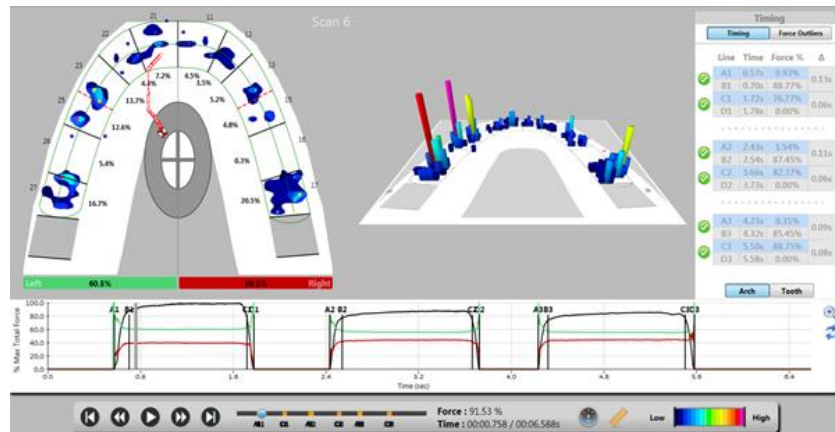
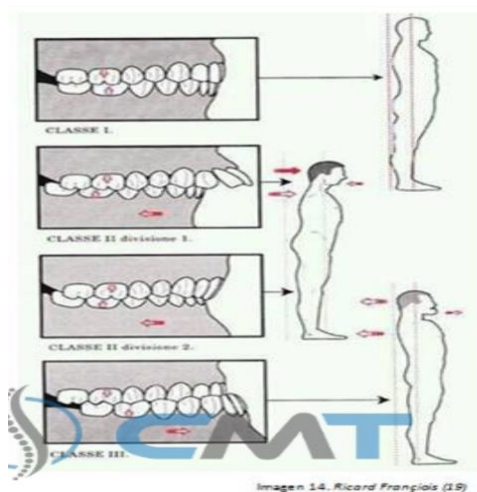


Fig. 4 A 3D force distribution diagram taken from 3 “bites” showing a good force of occlusion



(a)



(b)

Fig. 5 The link between the posture (a) and the TMJ dysfunction (b).

2. Classification of dental appliances and accessories [10-17]

Basic orthodontic appliances can be classified based on different criteria: purpose, mouth position, type of forces needed, retention etc.

Classification according to the purpose.

A. Curative appliances:

- (i) Mechanically acting;
- (ii) Functionally acting (through the muscle forces).

B. Prophylactic appliances:

- (i) Passive (bad habit);
- (ii) Active (creating new reflex) ;
- (iii) Placeholders.

C. Retention appliances: (i) removable (aligners); (ii) non-removable.

Classification according to mouth position:

- (i) Single-jawed (active on one jaw);
- (ii) Double-jawed (active on both jaws simultaneously);
- (iii) Single-jawed acting on both jaws; appliances placed in the oral vestibule.

Classification according to retention position:

- (i) Removable (attached, free);
- (ii) Non-removable (patient cannot remove them during treatment)

We also have fixed mechanically active orthodontic appliances - fixating elements and techniques. Fixed mechanically active orthodontic appliances are attached to the teeth. The teeth are moved by the elastic force of the orthodontic wire which has different properties. Steel, NiTi, CuNi, titanium and TMA wires are used the most. The common advantage is that they act constantly, independently of the patient's cooperation. The most used contemporary appliance is the multi lock technique [2]. Basic elements of fixed orthodontic techniques are:

1). Braces – made of metal alloys, they are positioned on the inner or outer tooth surface. They can be ceramic (esthetic) and steel.

Contemporary multi lock appliances are derived from the Angel's universal appliance. In 1925, he introduced the Edgewise technique which gives 3 dimensional control over all teeth, tooth segments and the entire arch. Additional devices can help correct interjaw relations. Tweed further developed and perfected this technique. Half a century later, Andrews created the Straight wire technique which became a new revolutionary possibility for the development of fixating techniques. With the Straight wire method, the information for the 3 dimensional position of every tooth is set in the bracket itself, the slot is specifically angulated for every tooth and the arches are straight.

Table 1 Materials for dental accessories

Appliances/ accessories	Materials/ technology	Dissemination in practice	Price	Properties/ requirements
Braces	Metal	+++	low	High corrosion resistance, high elasticity, good compatibility in mechanical characteristics with biological tissue.
	Ceramic	++	high	
	Polymer	+	medium	
Orthodontic appliances	Polymer + metal	+++	low	Toughness, low elasticity, moderate corrosion resistance, biocompatibility.
Aligners (MTM)	Polymer	+++	medium	Moderate corrosion resistance, good biocompatibility, low elasticity.
Ligatures	Metal	+++	high	Different elasticity
	Silicon	++	high	
Rings	Metal Soldering	++	medium	Different elasticity

2). Cannulas – for greater arch stability, it as a praxis to distally limit teeth using cannulas.

They are welded on the base of the bracket. The cannula lumen can have a round or angulated cut, analog to slot size. Cannulas are often double, with bracket-like wings or gingivally attached hooks.

3). Angulated appliances, arches.

According to the basic principal of orthodontic treatment the original arch shape should be kept because it gives the teeth maximal stability. Choosing the right wire arch is based on treatment stage, current goal, brackets type and slot size.

4). Other elements - orthodontic accessories such as hooks, stops, lingual buttons, loops that either help move single teeth or are hooks for elastic chains and slings.

The fixating technique goes through different stages, whilst teeth contacts change.

- Leveling stage (thin elastic NiTi arches are applies);
- Primary stage (the largest steel or TMA arches are needed);
- Contracting stage (angulated steel or TMA arches);
- Retention stage (with retention appliances. Passive fixed or removable aligners).

3. Materials and techniques used for accessories production.

Basic and most used materials are metals, ceramic and plastic. Table 1 shows the materials and their wanted properties.

CONCLUSIONS

- Metal usage comes down to steels and titanium alloys, but plastic products are increasingly sought after, especially because of their price, speed and flexibility considering patient's needs.
- Studying occlusion with digital technology is a perspective method that ensures a precise and expert diagnostics.
- Important: every medical action reflects on the entire body. Every dysfunction or clinically manifested TMJ can be caused by a problem elsewhere in the organism.
- Manual pretreatment may reduce clinical manifestations and make way for less invasive medical treatment.
- Multidisciplinary work is very important in preventing stopping and evading recidives.

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