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In Vitro Study Regarding the Biomechanical Behaviour of Bone, Fibre Reinforced Polymer and Wire Composite Periodontal Splints. II.Model Analysis

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Abstract: *This paper is the second part of a study regarding the biomechanical behaviour of mandibular bone in the context of different periodontal splinting systems, occlusal forces and load distributions. Electric resistive tensometry method was used to measure the strains developed in mandibular bone replica. The tests were carried out on six mandibular acrylic models, each with 8 natural teeth. The experimental groups were defined corresponding to the bone condition and splint type: normal height bone; bone resorption without splint; bone resorption and wire-composite splint; bone resorption and polyethylene fiber-reinforced composite splint. Each sample was subjected to three similar loading cycles, the force being applied successively on four incisors, two central incisors and canines, and the specific deformation values were read for four loading forces: 30 N, 50 N, 100 N and 150 N. In case of bone loss, the bone deformations are up to 110%. Periodontal splinting redistribute forces, reducing incisors bone strains associated with a slight increase in canine bone strains.*

Keywords*: periodontal splint, bone strain, electric resistive tensometry, fibre-reinforced composite*

1. Introduction

Periodontitis is a chronic infectious disease of the tissues surrounding the teeth caused by specific microorganisms or groups of specific microorganisms, characterized by gingival inflammation, loss of connective tissue attachment and destruction of alveolar bone [1-3]. With the reduction of periodontal attachment, mobility and dental migration appear, resulting in incorrectly distributed occlusal forces, which overload the already affected periodontal system. The relationship between occlusal trauma and tooth mobility depends on the intensity and frequency of occlusal forces [4].

The treatment of dental mobility in periodontal disease is determined by the degree of bone resorption. For teeth with increased mobility due to widening of periodontal space induced by the adaptation to the functional conditions of mastication, the treatment is a combination of occlusal adjustments and periodontal therapy. For teeth affected by gingival inflammation and increased mobility due to bone resorption, the treatment is a combination of periodontal therapy, occlusal adjustments and teeth immobilization [5-9]. Stabilization is achieved by periodontal splinting, which

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leads to redistribution of functional and para-functional occlusal forces. This helps the reorganization of the gum tissues, the periodontal fibers and the alveolar bone, consequently improving the masticatory and patient comfort [10,11]. The use of periodontal splint before the surgical treatment improves the predictability of the procedures and the tissues healing if the tooth movement is eliminated [12].

There are numerous immobilization systems: composite resins [6,13,14], wire mesh [13,15], fiber-reinforced composites [6,13,16].

While the clinical rational for splinting is less disputable in current scientific literature [16-21], the latest advances in splinting materials and the wide variety available [22] can create confusion among practitioners. There is even less information regarding the biomechanical response of the periodontal complex in the context of different bone resorptions and splints [23-33]. These aspects make splinting therapy to be a challenging decision for dental professionals.

The purpose of the study was to evaluate the biomechanical behaviour of mandibular bone by means of electric resistive tensometry method, in case of different periodontal splinting systems subjected to different occlusal forces. The method was described in the first part of this research, in a previous paper [34]. The premise of this research wa that the degree of the bone resorption and the type of the periodontal splint influence the tooth displacements and, consequently, the deformation of the mandibular bone, resulted in the recorded strain values.

2. Materials and methods

2.1. Mandibular acrylic models

The tests were carried out on six mandibular acrylic models (Duracryl Plus, Spofa Dental, Czech Republic, No. Batch: 2373741). The fabrication and validation of the models were previously described in detail [34]. In brief, each model comprised of eight extracted mandibular teeth, from the first right premolar, to the first left premolar. The periodontal ligament was replicated with a fluid condensation silicone (Oranwash L, Zhermack, batch No. 192139).

After performing mechanical tests on the initial model with bone integrity (normal height bone - NHB), 5 mm and 4.5 mm acrylate removal was performed on CIs and LIs, respectively, corresponding to bone resorption (BR) in marginal periodontitis. The mobility Periotest values (PTVs) of CIs and LIs were greater than 30 units, which justified the application of periodontal splinting.

2.2. Periodontal splints

The materials used for the periodontal splints are shown in Table 1. Construct (Kerr UK Ltd, Peterborough) is an ultra-high strength polyethylene fibre that has been cold gas plasma-treated and is pre-silanated with unfilled resin. Premise is a light-cured resin composite containing three different sized filler particles (tri-modal): prepolymerized fillers, 30-50 microns; bari-um glass, 0.4 microns; and silica nanoparticles, 0.02 microns.

Table 1. Materials used for dental splinting

Material	Producer	Batch no.	Type of material
Construct	Kerr	5102784	Non-impregnated woven polyethylene fiber 2 mm
Construct	Kerr	5100456	Impregnating resin
Premise Packable	Kerr	4957927	Nanofilled restorative composite packable
Premise Flow	Kerr	5123370	Nanofilled restorative composite flow
Wildcat .0195”	Dentsply GAC	171245	Twisted stainless steel wire
OptiBond XTR Adhesive	Kerr	4788988	Adhesive
Pegasus etchant gel	Astek Innovations	1209132	Orthophosphoric acid 37%
Light-curing unit	Woodpecker		Luminous intensity of 1200 mW/cm^2; wavelength of 430-480 nm

The first splinting system was wire-composite resin (WRC). The steps were as follows: (1) measuring the inter-canine distance and cutting the appropriate length of the twisted wire; (2) adapting and conforming the wire on the model; (3) degreasing of lingual surfaces; (4) etching of lingual and proximal accessible surfaces with orthophosphoric acid 37% for 30 seconds; (5) acid removal, surface washing and drying; (6) applying of the adhesive and light cure for 20 seconds / tooth with the tip of the light beam placed at a distance of 5 mm from the sample; (7) wire positioning and applying of the packable composite layer at the level of each tooth, followed by light curing for 40 seconds / tooth (Figure 1).

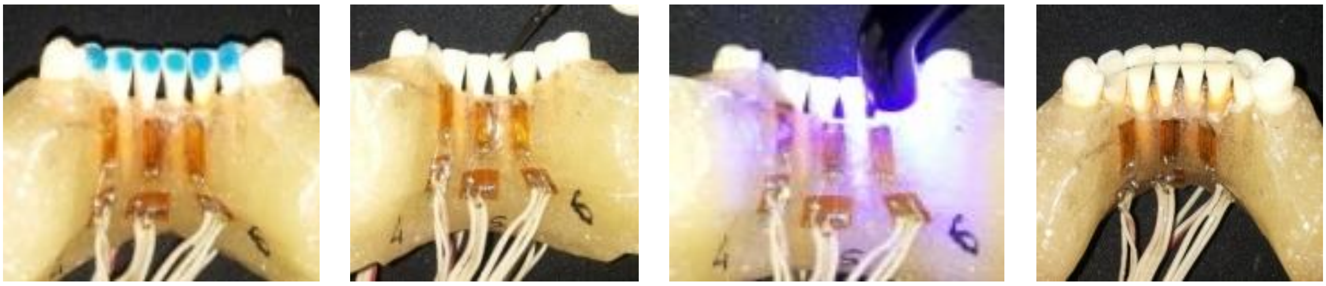

Figure 1. The steps for applying the wire-composite splint

After performing the mechanical tests on the wire-composite splint model, the splint was carefully removed in order to avoid the damage of the model and of the strain gauges.

The second immobilization system was the polyethylene fiber composite (FC). The steps were as follows: (1) measuring the inter-canine distance and cutting the corresponding strip of fiber band; (2) impregnation of the polyethylene fiber with the Construct resin; (3) degreasing of lingual surfaces; (4) etching of lingual surfaces with orthophosphoric acid 37% for 30 seconds; (5) acid removal, surface washing and drying; (6) adhesive applying and light curing for 20 seconds / tooth; (7) applying of a 0.2 mm layer of Premise composite; (8) adapting the impregnated polyethylene fiber and removing the excess of composite; (9) light-curing for 40 seconds / tooth; (10) applying a final layer of Premise flow composite to fully covering the fiber and light curing for 40 seconds / tooth (Figure 2).

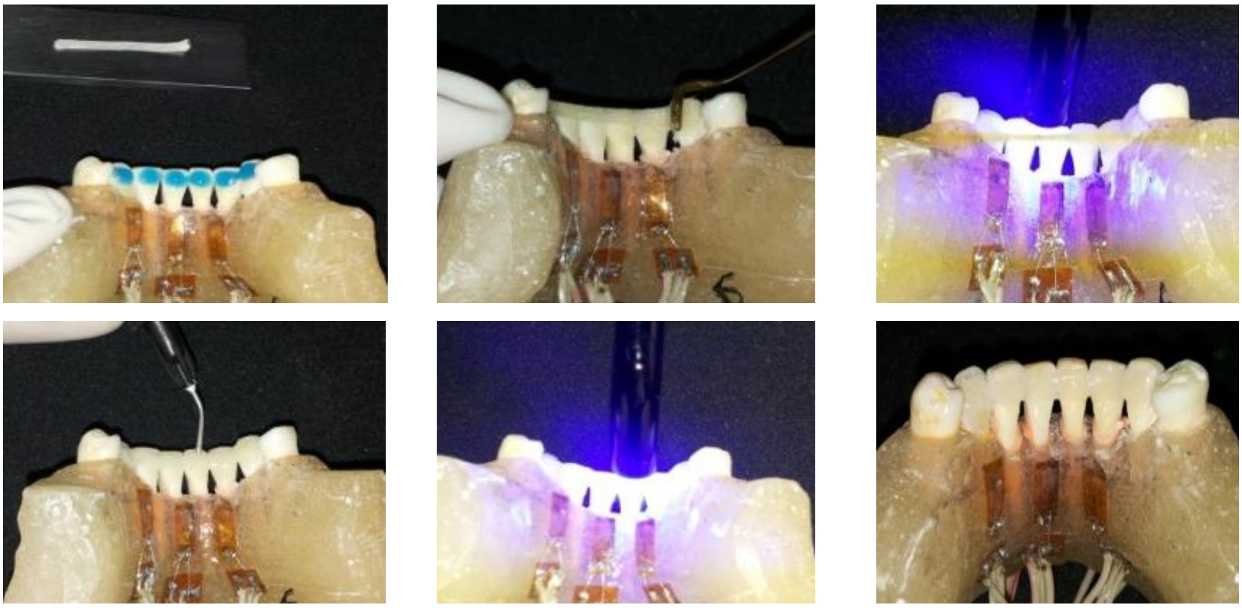

Figure 2. The steps for applying the polyethylene fiber composite splint

2.3. Mechanical testing of the samples

The mechanical testing protocol was also described in detail in the first part of this study [34]. It is presented briefly below.

6 mm length and 2 mm width strain gauges (SG) (EA-06-240LZ-120/E, Micro-Measurements Group, Vishay, Batch No.: R-A59AF524) were selected for quantifying the bone deformation. Their electrical resistance was 120 ± 0.03Ω at 24ºC. They were placed on the mandibular replica, corresponding to coronal-radicular axis as it follows: three on the buccal surface (SG 1 - right lateral incisor/RLI, SG 2 - left central incisor/LCI, SG 3 - left canine/LC) and three on the lingual surface (SG 4 - LC, SG 5 - LCI, SG 6 - RLI). A WDW-5CE High Performance Electronic Universal Testing Machine (Bairoe, Shanghai, China) was used to perform the compression tests and record the time-force variation. With a specially adapted device, the model was mounted on the test machine allowing an occlusal load orientation of 135° on the mandibular incisors that replicated the normal interincisal angle, and an individual loading on incisors and canines.

The load distribution was at the level of: (i) four incisors - 4I; (ii) two central incisors - 2I; (iii) canine - C. The samples were three times tested for each load distribution, with a load speed of 0.5 mm / min, 150 N maximum load, at room temperature (23° C) and with a 5 minute break before each test to allow for recalibration of the marks. The specific deformations provided by the strain gauges (in relation to time) were recorded with two strain gauge bridges P3 model (Vishay). The displacement values were read for the four loading forces: 30 N, 50 N, 100 N and 150 N, respectively.

A dial comparator was positioned in contact with the labial middle third of RLI, which allowed the horizontal tooth displacement measurements with an accuracy of ± 0.01 mm (Figure 3).

The experimental groups were defined corresponding to the bone condition and splint type as it follows: models with normal height bone (NHB); models with bone resorption without splint (BR); models with bone resorption and wire-composite splint (WRC); models with bone resorption and polyethylene fiber-reinforced composite splint (FRC). Each sample was subjected to three similar loading cycles, the force being applied successively on 4I, 2I and C, and the specific deformation values expressed in με (equivalent to μm/m) were read for four loading forces: 30 N, 50 N, 100 N and 150 N.

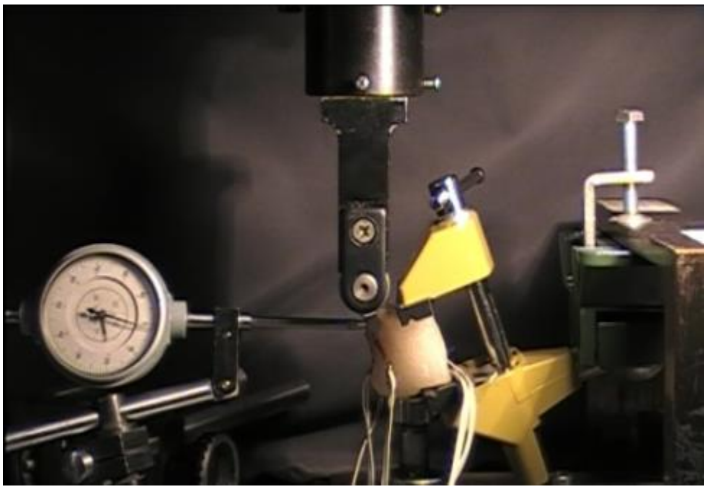

Figure 3. Positioning the model on the machine support

2.4. Statistical analysis

Statistical data analysis was performed with STATISTICA 11.0 (Stat-Soft, Tulsa, OK), at a significance level of 0.05. Factorial analysis of variance (ANOVA) was employed to evaluate the effect of four variables: bone condition and splint type (BC), mandibular bone surface (BS), load distribution (LD), and tooth position (T) on the bone strain in the context of different occlusal loading.

3. Results and discussions

The dental mobility was re-evaluated after applying each immobilization system and the results are presented in Table 2.

The horizontal displacement values of RLI are presented in Table 3.

Bone strains values expressed in με (equivalent with μm/m) for every situation referred above were read for the four forces 30N, 50N, 100N and 150N (Table 4).

Table 2. The means (standard deviations) of PTVs on the model with bone resorption and splint

Tooth	RP	RC	RLI	RCI	LCI	LLI	LC	LP
BR	1.0 (0.2)	-1.0 (0.5)	27.3 (1.5)	34.7 (2.5)	41.3 (2.5)	28 (2.0)	-0,8 (0.2)	0.1 (0.4)
WRC	1 (0.2)	-0,8 (0.3)	2 (0.1)	3 (0.3)	4 (0.2)	3 (0.4)	1,1 (0.4)	0,1 (0.1)
FRC	1 (0.2)	-1 (0.2)	1,6 (0.2)	2 (3)	3,4 (0.1)	0,4 (0.0)	0,8 (0.2)	0,1 (0.0)

RP = right premolar; RC = right canine; RLI = right lateral incisor; RCI = right central incisor; LCI = left central incisor; LLI = left lateral incisor; LC = left canine; LP = left premolar; BR = bone resorption, WRC= wire-composite splint; FRC = fiber-reinforced composite splint [34].

Table 3. The horizontal displacement values of RLI (mm)

Load (N)		NHB			RB			WRC			FRC		
		4I	2I	C	4I	2I	C	4I	2I	C	4I	2I	C
30	*Mean*	0	0.01	0	0.05	0.45	0	0.01	0.02	0	0	0.05	0
	SD	0	0.0005	0	0.0035	0.045	0	0.0014	0.0028	0	0	0.0025	0
50	*Mean*	0.01	0.033	0	0.25	0.95	0	0.02	0.04	0	0.013	0.035	0
	SD	0.002	0.006	0.000	0.053	0.238	0.000	0.000	0.001	0.000	0.002	0.006	0.000
100	*Mean*	0.015	0.043	0.008	0.96	1.28	0.05	0.045	0.051	0.01	0.018	0.045	0.01
	SD	0.003	0.006	0.000	0.030	0.143	0.000	0.001	0.006	0.000	0.002	0.006	0.000
150	*Mean*	0.040	0.055	0.01	1.17	1.55	0.2	0.03	0.066	0.025	0.028	0.06	0.015
	SD	0.002	0.007	0.001	0.176	0.388	0.044	0.006	0.009	0.001	0.002	0.013	0.003

I=incisor; C = canine; NHB = normal height bone; BR = bone resorption; WRC = wire-composite splint; FRC = fiber-reinforced composite splint; SD = standard deviation

Table 4. Bone strains values (με) for the four compression loads

Force	Group	Contact	SG 1		SG 2		SG 3		SG 4		SG 5		SG 6	
			Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
30	NHB	4I	92	10.12	151	6.04	15	0.30	13	2.99	110	16.50	65	8.45
		2I	13	2.99	298	53.64	10	0.60	9	0.99	260	7.80	10	2.00
		C	21	5.04	30	3.00	557	44.56	532	15.96	22	5.50	13	0.65
	BR	4I	143	20.02	250	50.00	16	4.00	13	2.21	178	35.60	110	4.40
		2I	32	5.44	547	54.70	12	1.20	10	0.70	486	68.04	28	2.52
		C	20	4.00	31	2.48	579	115.80	561	22.44	22	4.62	10	0.40
	FRC	4I	102	20.40	150	19.50	35	5.95	31	4.96	108	3.24	66	13.86
		2I	66	15.84	191	30.56	33	5.94	30	6.30	180	28.80	48	6.72
		C	80	3.20	110	12.10	534	85.44	518	62.16	100	17.00	70	3.50
	WRC	4I	91	10.01	149	5.96	32	1.60	28	3.92	108	8.64	64	10.88
		2I	58	4.06	187	35.53	28	5.88	27	3.51	166	6.64	47	7.05
		C	95	7.60	114	25.08	540	10.80	525	10.50	105	15.75	87	9.57
50	NHB	4I	123	30.75	205	12.30	17	3.40	14	2.10	153	16.83	92	21.16
		2I	23	4.83	400	88.00	10	1.60	10	2.20	361	14.44	16	2.56
		C	29	4.06	34	1.70	689	144.69	673	94.22	26	2.34	17	2.89
	BR	4I	202	46.46	357	24.99	18	1.26	14	0.56	262	10.48	157	12.56
		2I	39	8.19	730	87.60	14	0.98	11	0.66	647	161.75	37	6.66
		C	31	4.65	47	6.58	715	21.45	702	56.16	32	5.12	19	2.28
	FRC	4I	131	13.10	229	20.61	54	3.78	43	9.03	162	34.02	101	6.06
		2I	88	11.44	314	69.08	49	9.80	43	8.60	273	8.19	65	13.65
		C	107	18.19	131	9.17	665	139.65	634	19.02	120	10.80	98	14.70
	WRC	4I	126	10.08	203	26.39	53	2.65	41	8.61	151	24.16	90	5.40
		2I	85	19.55	303	60.60	46	10.58	40	5.60	259	5.18	62	7.44
		C	113	24.86	134	30.82	670	26.80	642	25.68	125	5.00	105	22.05
100	NHB	4I	230	9.20	421	29.47	19	1.33	15	2.70	337	6.74	194	27.16
		2I	38	1.90	800	200.00	12	2.88	13	2.73	680	47.60	23	1.38
		C	35	4.90	40	0.80	982	206.22	964	134.96	32	7.04	19	0.95
	BR	4I	365	47.45	661	125.59	21	2.52	18	1.08	541	129.84	314	47.10
		2I	54	13.50	1390	97.30	15	2.40	15	1.65	1182	130.02	41	6.56
		C	41	6.15	49	2.45	1019	203.80	989	49.45	39	7.80	25	4.50

	FRC	**4I**	244	12.20	452	40.68	81	3.24	77	6.16	340	34.00	238	40.46
		2I	129	25.80	608	91.20	79	6.32	64	10.24	574	74.62	92	2.76
		C	130	5.20	162	37.26	913	219.12	896	107.52	131	13.10	83	8.30
	WRC	**4I**	237	52.14	405	60.75	80	4.80	75	5.25	327	45.78	195	46.80
		2I	131	9.17	588	99.96	74	9.62	61	10.98	565	107.35	93	22.32
		C	139	27.80	173	25.95	921	119.73	904	117.52	138	5.52	88	2.64
150	**NHB**	**4I**	330	36.30	616	73.92	21	2.31	16	3.52	510	45.90	281	50.58
		2I	49	9.80	1170	152.10	12	0.36	14	0.84	1014	233.22	37	8.88
		C	44	4.40	52	9.36	1287	102.96	1279	217.43	48	12.00	34	7.48
	BR	**4I**	542	59.62	962	192.40	23	5.52	20	2.60	813	186.99	471	108.33
		2I	64	10.24	1710	51.30	17	2.38	16	2.40	1528	229.20	52	6.24
		C	52	9.88	59	2.95	1321	66.05	1294	38.82	48	10.56	36	3.60
	FRC	**4I**	362	28.96	664	33.20	110	18.70	91	2.73	548	98.64	401	84.21
		2I	148	23.68	910	118.30	92	16.56	88	3.52	782	132.94	123	17.22
		C	193	17.37	215	30.10	1204	108.36	1183	260.26	180	19.80	162	30.78
	WRC	**4I**	329	19.74	610	73.20	110	23.10	82	16.40	508	66.04	282	50.76
		2I	154	12.32	915	100.65	89	19.58	87	20.88	779	54.53	134	33.50
		C	201	28.14	223	33.45	1215	36.45	1189	35.67	192	26.88	173	15.57

I=incisor; C = canine; NHB = normal height bone; BR = bone resorption; WRC = wire-composite splint; FRC = fiber-reinforced composite splint; SG = strain gauge; SD – standard deviation

The factorial ANOVA indicated significant differences between the four factors (load distribution, bone condition, bone surface, tooth; P <0.001), irrespective of load level. For the 2-factor interactions, the following interactions were significant for all load values (P <0.001): bone condition and load distribution, bone condition and tooth, load distribution and tooth, and bone surface and tooth. Of the 3-factor interactions, only the bone condition, load distribution, and tooth interaction was statistical significant irrespective of load level.

Table 5. Results of factorial ANOVA for data obtained with the four l
oadings (dependent variable: strain)

	30 N					**50 N**					**100 N**					**150 N**				
	SS	**df**	**MS**	**F**	**p**	**SS**	**df**	**MS**	**F**	**p**	**SS**	**df**	**MS**	**F**	**p**	**SS**	**df**	**MS**	**F**	**p**
Intercept	11467759	1	11467759	20982.50	<.001	20205946	1	20205946	30160.28	<.001	54609749	1	54609749	35342.74	<.001	35990215	1	35990215	33709.67	<.001
{1}BC	154495	3	51498	94.23	<.001	333679	3	111226	166.02	<.001	895048	3	298349	193.09	<.001	5238738	3	1746246	1635.59	<.001
{2}LD	1901151	2	950576	1739.26	<.001	2245376	2	1122688	1675.77	<.001	1510566	2	755283	488.81	<.001	286539	2	143269	134.19	<.001
{3}BS	37828	1	37828	69.21	<.001	120919	1	120919	180.49	<.001	165230	1	165230	106.93	<.001	160091	1	160091	149.95	<.001
{4}T	1967876	2	983938	1800.31	<.001	3208895	2	1604447	2394.87	<.001	9725482	2	4862741	3147.10	<.001	4007369	2	2003685	1876.72	<.001
BC*LD	292973	6	48829	89.34	<.001	352690	6	58782	87.74	<.001	906249	6	151041	97.75	<.001	4107320	6	684553	641.18	<.001
BC*BS	1688	3	563	1.03	0.379	4775	3	1592	2.38	0.069	10298	3	3433	2.22	0.085	8185	3	2728	2.56	0.055
LD*BS	11891	2	5946	10.88	<.001	10487	2	5244	7.83	<.001	13187	2	6594	4.27	0.015	4268	2	2134	2.00	0.137
BC*T	318028	6	53005	96.98	<.001	565802	6	94300	140.76	<.001	1737060	6	289510	187.37	<.001	20461568	6	3410261	3194.17	<.001
LD*T	11584065	4	2896016	5298.83	<.001	19122091	4	4780523	7135.62	<.001	50771551	4	12692888	8214.68	<.001	2237909	4	559477	524.03	<.001
BS*T	9668	2	4834	8.84	<.001	18730	2	9365	13.98	<.001	73364	2	36682	23.74	<.001	19847	2	9924	9.29	<.001
BC*LD*BS	3843	6	641	1.17	0.320	5115	6	853	1.27	0.268	7569	6	1262	0.82	0.557	21042	6	3507	3.28	0.004
BC*LD*T	690389	12	57532	105.27	<.001	1316620	12	109718	163.77	<.001	3221440	12	268453	173.74	<.001	6234195	12	519516	486.60	<.001
BC*BS*T	7287	6	1215	2.22	0.040	10612	6	1769	2.64	0.016	25700	6	4283	2.77	0.012	28697	6	4783	4.48	<.001
LD*BS*T	9684	4	2421	4.43	0.002	52832	4	13208	19.71	<.001	42002	4	10501	6.80	<.001	10584	4	2646	2.48	0.043
1*2*3*4	5340	12	445	0.81	0.636	9970	12	831	1.24	0.252	61746	12	5145	3.33	<.001	11929	12	994	0.93	0.515
Error	275456	504	547			337656	504	670			778754	504	1545			538097	504	1068		

Static tests with maximum compressive force values of 150 N were performed. The models were subjected to three similar test cycles for each of the above-mentioned situations and the deformation values for four values of the force (30 N, 50 N, 100 N and 150 N) were recorded. These values were chosen because the literature data reported occlusal forces in the anterior mandible region between 40 and 200 N [35, 36]. The purpose of the study being bone deformation quantification and not fracture resistance of splints, intermediate physiological loading values were used. These values might not describe some particular situations when splints are subjected to much larger forces due to lateral edentulism and consecutive occlusal forces concentration in frontal dental area [8].

Deformations values in the anterior region of the mandible were directly proportional to the load values of the four forces. Even small forces applied cyclically over a period of time, can cause a phenomenon of fatigue or interfere with tissue healing processes, taking into account the small size of the bone structure in this region. In all simulated situations, higher values of deformations were observed on the buccal surface, aspect also reported by Soares et al. This can be explained by a smaller thickness of the labial bone compared to lingual bone [36].

It was noticed that, regardless of the value and of the loaded area, strains in group BR were significantly greater than strains in the group NHB, and those in groups WRC and FRC had intermediate values, but closer to NHB group. In addition, strains at the central incisor were higher by 60-85% than at the lateral incisor, except when the contact was made on the canine.

Comparing the BR to NHB groups, a severe increase of strains was observed, both on lingual and labial surfaces, the highest difference (73%) was recorded for 100N force, on buccal for central incisor in BR_{2I} group.

It can be noticed that in the groups with periodontal splinting (WRC and FRC), occlusal forces were distributed to all tooth in the splint, as demonstrated by the modified strain values.

Another quantified parameter with clinical relevance is the tooth contact. When the force is applied to the central incisors, the strains values are 60% higher than when force is balanced applied at the four incisors.

Another interesting aspect is that when force is applied to the incisors, bone strains in FRC group were higher than in WRC group with no significant differences. This suggests a more elastic behaviour of polyethylene fibers than of the wire-composite system.

When contact was at the canine, comparing the distribution of bone strains from the canine, it was observed that in WRC group the strains were higher by 18 % compared with FRC group, regardless of the force. Due to the intern stiffness of the wire, a reduction in incisors strains can be achieved, which has as disadvantage the consecutive increase of canine strain. In the context of constant overloading, the adaptive level of canine support tissues may be exceeded, thus favouring the progression of bone resorption.

Differences between wire-composite splint and fibre-reinforced composite splints may occur also from clinical behaviour point of view. Thus, the wire - composite resin splint has an interface between two materials with different modules of elasticity (stainless steel and composite resin) without chemical adhesion. Thus, in this area fracture initiation may occur, because the splint exhibits low fatigue strength [16, 25].

Regardless the contact between the loading device and the dental surfaces, higher values are observed to lateral incisor in the group BR, versus group NHB, for all four forces. For groups WRC and FRC, horizontal displacement value decreased, but remained higher than in NHB group regardless of force level. No significant differences of displacement values were observed between the two splinting groups. The displacement values in the group BR_{2I} were higher up to 300% compared to BR_{4I}, which reinforce the need of balanced occlusion in order to achieve multiple contacts on the four incisors for an even distribution of occlusal forces.

In a study by Soares et al. [36], based on electric tensometry method, the bone strains were compared when adhesives splinting systems (composite resin, wire resin and fiber-reinforced composites) and wire splinting were applied. The authors noted that bone strains values in case of wire splinting were significant higher compared with the FRC splinting. To a force of 150 N, the wire did not achieved significant stabilization of mobile teeth. According to these results, the use of the wire without application of a composite resin and an adhesive system is not suitable in the splinting periodontal treatment. In the same study, the authors pointed out that dental splints with adhesive system and composite resin produced lower bone strains irrespective of occlusal load.

The results obtained should be interpreted in the context of the limitations of this study. The tests were performed in vitro so that all parameters of the bone and dento-periodontal substrate could not be reproduced: cortical bone and spongy bone, different bone densities, vascularization, dental innervation, viscoelastic properties of the periodontal ligament [37]. Clinically, other factors as frontal edentulism, employed materials [38], modified prosthetic values of the teeth [39], surface quality of the restorations and teeth [40-44] can influence the biomechanical performance of the splinting system. Also, the compression tests were static without simulating the cyclic, repetitive loads exerted in the oral cavity.

4. Conclusions

1. For the groups with periodontal splinting, horizontal displacement values were reduced, but remained higher than in the group with normal bone.
2. Regardless of the load values and distribution, strains in BR group were significantly greater than strains of NHB group and the groups FRC and WRC had intermediate values, but closer to the BR group.
3. In case of bone loss, the bone deformations are up to 110%, regardless of the load value and distribution. Periodontal splinting redistribute forces, reducing incisors bone strains associated with a slight increase in canine bone strains.
4. When a force was applied to the incisors, bone strains in the group FRC were higher than in the group WRC with no significant differences. When force was applied to the canine, regardless of the force value, canine bone strains were higher by 18 % in the WRC compared with FRC group.
5. Periodontal splinting must be correlated with a balanced occlusion, to allow occlusal forces to be applied to an enlarged area, on the four incisors, which allows a strain reduction up to 63% compared to the situation in which the force is applied only on central incisors.

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