Nano-ceramic Particle Reinforced Coposite - Lava Ultimate CAD/CAM Restorative

SORIN MIHALI[1], CRISTINA BORTUN[2]*, EMANUEL BRATU[1]

[1] University of Medicine and Pharmacy "Victor Babes", Timisoara, Department of Prosthodontics, 2 Eftimie Murgu Sq., 300041, Timisoara, Romaia.

[2] University of Medicine and Pharmacy "Victor Babes", Timisoara, Department of Dental Technology, 2 Eftimie Murgu Sq., 300041, Timisoara, Romaia.

The purpose of this prospective study was to evaluate the influence of a new restaurative material (Nano-ceramic particle reinforced composite – Lava Ultimate CAD/CAM Restorative) on implant bone resorbtion and its behaviour to oclusal ware. One operator inserted two implants on each side of the mandibula at 12 patients. After 3 month the prosthetic restorations were placed on the implants. The bone lost was evaluated by using initial X-rays and X-rays after 3 months of wearing the prosthetic restorations. The oclusal ware behaviour was assesed by comparing the initial dimensions of the restauration with the dimensions after 3 months from the intraoral placement. The results showed that these materials are suitable for prosthetic restauration on implants.

Keywords: nano-ceramic material, dental implant,bone remodeling, usage behaviour, mini-invasive treatment

Nano-ceramic particle reinforced composite were created by incorporating Al_2O_3 ceramic particles into the surface of AA6061-T6 alloy plate with multiple pass friction stir processing [1]. When compared to unreinforced aluminium alloys, aluminium matrix composites reinforced with ceramic phases exhibit higher strenght and stiffness, improved tribological characteristics and increased resistance to creep and fatigue [1]. Furthermore, most of the conventional resin matrix is replaced by a matrix full of highly dispersed methacrylate modified polysiloxane particles (2-3nm). According to the manufacturer's information, the nano-ceramic particles are inorganic-organic hybrid particles. Both, nano-ceramic particles and nano-fillers have methacrylate groups available for polymerization [2]. Recent studies reveal that the metal matrix composited reinforced by nano-sized ceramic powder exhibit superior wear resistance by having significantly low wear rates and desired abrasive wear. Strenght is an important aspect of the material for mechanical and particular applications under loading and static pressure [3]. For applications where surface contact is involved, the useful life of components is mainly determined by their surface properties such as wear resistance [4]. Brittleness is a main reason limiting ceramic tools to be used widely, the dispersion of nano-scale second particles in ceramic matrix composites can result in considerable improvements in mechanical properties to overcome the inherently low fracture toughness of ceramic materials [5,6].

A resin nano ceramic has an elastic modulus that is comparable to dentin, which is much lower than what brittle ceramic materials or metalo-porcelain prostheses can provide. This enables Lava Ultimate CAD/CAM Restorative material to better absorb chewing forces and reduce stress to the implant, having 200 MPa toughness.This is especially advantageous for implant restorations. The lack of periodontal ligament, which normally serves as shock absorbance or sensory function may lead to crown fracture or chipping.

The aim of this work is to study the influence of a new nano-ceramic particle reinforced composite related to the oclusal wear and implant bone resorbtion.

Experimental part

The study was performed at the School of Dentistry, University of Medicine and Pharmacy "Victor Babes", Timisoara. Twelve patients aged between 34 and 64 years agreed to participate in the study. The experimental design study was approved by the Local Ethics Committee.

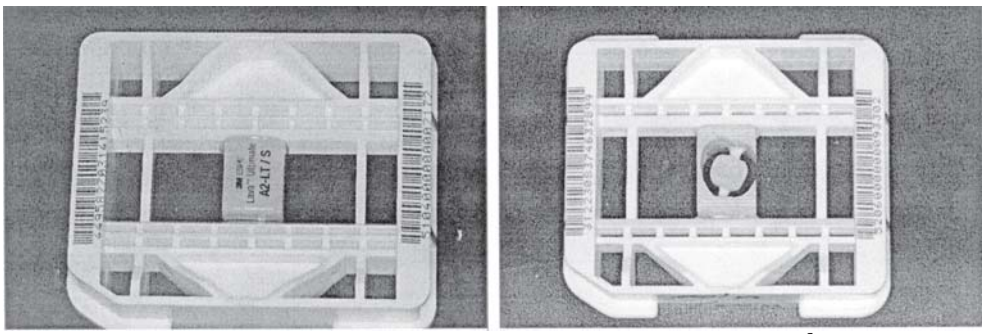
One operator (E.B.) inserted 32 C1 implants with diameter of 4.2 mm and the length ranged between 10mm and 11,5 mm. Twelve patients were carefully selected. All patients showed good oral health and were non-smokers. All implants were inserted in pairs in mandibular free end situations, in consolidated bone. Insertion torque did not exceed 55Ncm. Serum irrigation was applied during all phases.

After insertion, all implants received healing screws, provided by the manufacturer for every implant. No uncovering of the implants was necessary. Impressions were taken 3 month after the surgical phase, in order to obtain the final prosthetic restorations.

After 3 month from insertion the prosthetic restorations were placed on the implants. The CAD/CAM machine used for obtaining the prosthetic restorations belongs to 3M ESPE LAVA. There where used only specially designed blocks LavaTM Ultimate Restorative(fig.2a), size S (small) and A2 shade with LT-Low Translucency.The milling of the restaurations was carried out with the CAM milling machine, belonging also to 3M ESPE LAVA [10], resulting in the final restaurative prosthese (fig.2b)

The oclusal ware behaviour was assesed by comparing the initial dimensions of the restoration with the dimensions

* *email: cristinabortun@yahoo.com; Tel.: 0745378254*



a b

Fig. 1. a. LavaTM Ultimate Restorative Block; b. Final Restaurative Prosthese

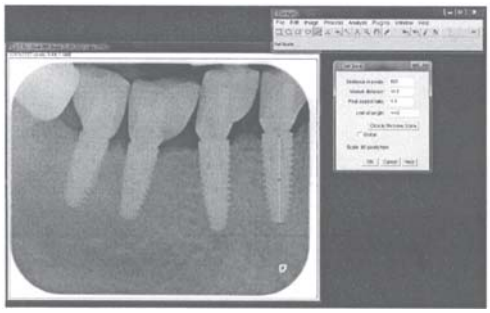


Fig.2. Calibration in mm by using the software Image J.

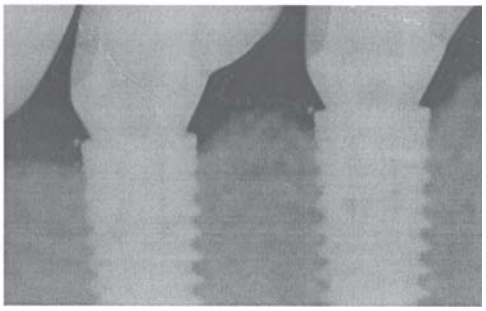


Fig.3.The measurements. The distances from the implant platform to the bone level were marked with red dots on the distal side of the implant

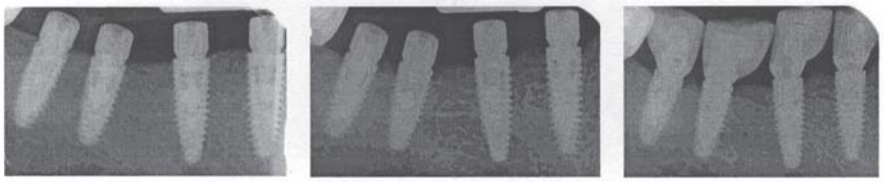


Fig. 4. Standardized radiography. a – at the time of insertion; b – at 3 month; c – at 6 month follow-up with final restoration

after 3 month from the intraoral placement. These measurements were obtain by using 3M ESPE Lava Design 7.2 software. With this program the restorations were scanned after ajusting the occlusion and before the cementation. All restorations were cemented with long term provisional cement (Dentotemp), destined as permanent cementation material of implant-retained crowns and bridges. After 3 month the restaurations were removed and re-analysed with the Lava Design 7.2 software. The results were compared with the initial situation.

The bone lost was evaluated by using initial X-rays and X-rays after 3 months of intraoral function. All X-rays were performed with the same device Planmeca ProMax 3D (Planmeca Oy, Helsinki, Finland). The measurments were carried out by using the software Image J together with a digital ruler. Initial X-rays were obtained imediately after the insertion of the implants while the comparing X-rays were performed at follow-up appointments (3 month from inserting the prosthetic restoration).

The analyze for periimplant bone remodeling was radiographically accomplished. Bone measurements were performed at the insertion moment, at 3 months and at 6 months. The results were analyzed using software Image J 1.46r. Each radiographic image was calibrated at a 1:1 scale, knowing the length in mm for the implants, from the platform level until its apex (fig. 2). Bone loss was measured in mm distally for each implant. The measurement was carried out from the implant platform to the bone level, keeping in mind that each implant was placed at the crestal level (fig. 3). The measurements were performed at the surgical phase, after 3 and respectively after 6 month, having a 3 month period of intraoral wear of the prosthetic restaurations.

Results and discussions

From the total of 12 patients included in this clinical investigation, 9 were men and 3 women, with ages ranging from 34 and 64, with a mean of 52.5 years old. All the implants were osteointegrated and all the patients completed the 3 and 6-month follow up examination (fig. 4).

The differences in bone loss at 3 and respectively at 6 months from insertion as well as the bone reshaping after loading the implants are presented in tabel 1. There were no significant differences between women and men regarding the bone loss (fig. 5). The mean values of crestal bone loss at the 3 month after the insertion were 1.30 mm for men and 1.27 mm for women.

Following our research it was determined that the nano-ceramic restoration reduced up to 50% of the bone loss. By using this restaurations it was observed a pression reduction in the peri-implant bone. The forces developed on the implant were diminuated due to the elasticity of the restaurations [7].

The study was conducted over a period of 6 month, during which time there were no implants lost. This clinical

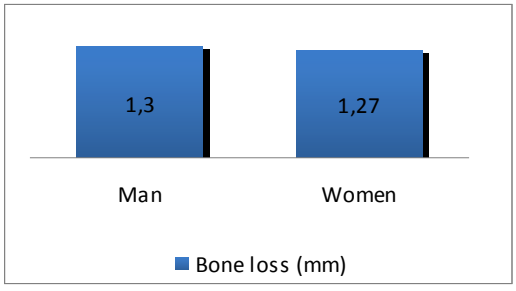


Fig. 5. Difference between men and women at 3 month after insertion

Table 1
DIFFERENCES IN mm AT THE CRESTAL BONE LEVEL AT 3 MONTH (WHEN THE PROSTEHTETIC RESTAURATIONS WERE INSERTED INTRAORALY) AND AT 6 MONTHS

Name	Surgical phase		3 months		6 months		Mean	
	M	W	M	W	M	W	M	W
C. C.	0	0	2.48	1.95	2.39	2.55	2.43	2.25
S. M.	0	0	0.95	0.79	1.77	1.34	1.36	1.06
C. I.	0	0	0.71	0.88	0.85	0.85	0.78	0.86
C. I.	0	0	1.63	0.83	1.56	1.12	1.59	0.97
P. I.	0	0	0.89	1.58	0.78	1.51	0.83	1.54
P. I.	0	0	0.59	1.69	0.68	1.27	0.63	1.48
S. D.	0	0	1.18	0.79	1.06	1.32	1.12	1.05
I. A.	0	0	1.04	0.75	2.34	1.22	1.69	0.98
Total mean C vs. S							**1.30**	**1.27**

** data are presented in mm*

** M –man and W – woman*

success may be due to the Lava Utimate nano-ceramic material. The primary stability was accomplished in all cases.

Following our measurements with the Lava 7.2 software it was established that the bone loss is minimum after 3 month of intraoral function. In the entire period non of the restauration fractured. The oclusion remained stable for all restaurations.

Lava Ultimate CAD/CAM Restorative was the only material investigated that maintained its initial strength when changing from dry to wet conditions. Initial strength of Lava Ultimate Restorative was higher than the feldspathic glass ceramic and the CAD acrylic composite and lower than lithium disilicate [8]. All materials show a decrease in strength upon cycling fatigue in water [9].

Based on its high flexural strength and high fatigue resistance, the material is ideal for challenging cases like implant supported crowns.

Conclusions

Within the limitation of this study it can be assesed that the nano-ceramic reinforced composite seems to be a promising material for fixed prosthetic restaurations on implants. Showing reduced implant bone resorbtion and also no oclusal wear on a 3 month period of intraoral evaluation. The mechanical properties of this new material sugest that it can be succesfully used in implant dentistry. Further studies will be neccesary to asses its long term intraoral behaviour.

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