

OPINION

by: **Assoc.-prof. Ilian Vangelov Hristov, DMD, PhD**, Department of Prosthetic Dentistry, FDM – Plovdiv, member of the scientific jury, order № P – 109-599/23.12.2020 of the rector of Varna’s Medical University, about PhD thesis:

CASTED METAL RESTORATIONS, CONSTRUCTED FROM 3D PRINTED PROTOTYPES USING LASER STEREOLITHOGRAPHIC PRINTER

for awarding educational and scientific degree “Doctor”, in doctoral program Prosthetic dentistry, professional field 7.2. Dental medicine, Higher educational sphere 7. Healthcare and Sports

PhD student: **Dr. Preslav Plamenov Penchev**, assistant – professor, Department of Dental Materials and Preclinics of Prosthetic Dentistry, Medical University – Varna

Scientific advisor: **assoc.-prof. Stoyan Georgiev Katzarov, DMD, PhD**, Department of Dental Materials and Preclinics of Prosthetic Dentistry, Medical University – Varna

General presentation of the procedure and the doctoral candidate

The presented set of materials is in accordance of the procedure for awarding of educational and scientific degree “Doctor”, in MU – Varna and the regulations of MU – Varna and includes all necessary documents.

Dr. Preslav Plamenov Penchev was born in the town of Rousse. He completes his education in the School of Mathematics, specialty: *computer science*. He graduated with master’s degree from the Medical University – Varna, specialty: *dental medicine*. He successfully graduated doctoral school, speaks and writes both in English and Russian.

Structure of the PhD thesis

The presented for revision PhD thesis includes 160 pages, divided into 7 chapters, 4 tables and 78 figures. The references include: 180 articles, 26 in Cyrillic and 164 in Latin.

Relevance of the PhD thesis

The PhD thesis considers the application of 3D prototypes fabricated by using laser stereolithographic printer. The topic is relevant, having in mind that casting is still a basic method for manufacturing of prosthetic restorations in dental medicine. Recently there is a rapid development of the new technologies and their application in dental practice. It is connected with the use of intra- and extraoral scanners, CAD – CAM technologies and 3D printing. The variety of problems, usually associated with the use of conventional methods for manufacturing of prosthetic restorations, forces seeking of new technologies and materials, which is the aim of the PhD thesis: *“to investigate the possibilities for manufacturing of casted metal restorations using 3D printed prototypes by laser stereolithographic printer.”*

Analysis of the literature review

The literature review covers 36 pages, showing the excellent knowledge of the problem by the candidate. The thesis is written in good Bulgarian language and scientific style. The quoted articles are up-to-date and relevant to the topic. The methods of additive and subtractive manufacturing of prototypes, as well as the benefits and shortcomings of the different materials needed for their manufacturing are revealed. The basic additive technics in modern dentistry, such as: SLA, FDM, SEBM, SLS, SLM, IJP are been covered. Besides these modern technologies, the candidate pays attention to the classical methods of casting, as well as the materials used, such as: different types of waxes, resins, investment materials and alloys. The literature review ends with a conclusion, which is an argumentation for the aim and the connected tasks in the thesis.

Analysis of the aim and the tasks

The aim of the PhD thesis is clearly and very well defined. For achieving the aim, the candidate sets four tasks, the first and last have two subtasks, and the second – three. Each of the tasks ends with a data analysis.

- *First task.* Subjected to different temperature changes, the investigated materials show different physical changes. Besides the generally used waxes, the changes in materials based on MMA and light-curing esters of methacrylic acid are also been investigated /Castable resin/. The ash remnants are negligible in all investigated products. As far as the volumetric changes during heating are concerned, some of them may be harmful, which imposes modifying the temperature mode in heating the flasks.
- *Second task.* The results achieved in this task show the significance of the correct orientation of the of the prototypes during 3D printing, according to the three-dimensional axes. The importance of the thickness of the layers, as well as the viscosity of the material is been evaluated. It's been advocated the elements to be situated at an angle towards the platform, so that the first layer to cover as small as possible area. The influence of the additional polymerization has been taken into consideration, because alongside with the improvement of the mechanical properties of the material, it will lead to polymerization shrinkage and dimensional deviations in the final product.
- *Third task.* Using the idea of reducing the ratio: weight/volume, the candidate fabricates three groups of samples: solid, hollow and with an aperture. Reducing the volume by 70%, as well as giving the opportunity of irrigation with alcohol, the smallest remnants of unpolymerized resin can be removed. Thus the evacuated during the process of sublimation gases exert lower pressure to the inner surface of the flask, preventing it from destruction. It's been payed attention to the importance of the mechanical properties of the investment materials, as well as the correctly chosen temperature mode.
- *Fourth task.* The candidate correctly defines the process of casting as inadequate and time-consuming. That's why he proposes its digital optimization, using the software of the 3D printer and as alternative of the classical modeling wax, the use of material, consisting of 80% resin and some 20% wax, which is far more durable. The digitalization of the process, leads to the creation of an utterly completed casting system with an absolutely new philosophy, controversial to the classical ones, eliminating the need of adaptation towards the dimensions of the existing flasks. The exact location of its components is the advantage of this newly created system.

Contributions

Based on the overall development five original contributions, three confirmative and two with applied character have been formulated. Registered and documented are the macroscopic changes in the samples, during the process of thermal elimination. It's been proved (despite the manufacturer's recommendations), that the postpolymerization of *Castable Resin* is not mandatory, but it also leads to deformation of the patterns. It's been pointed out the role of the weight and the volume of the objects for the overall pressure to the inner walls of the flask. It's been confirmed the possibility of usage of other investment materials with *Castable Wax* and *Castable Resin* (not only the recommended ones by the manufacturer). The important role of the direction of the 3D printing process has been pointed out. A method for digital planning of 3D printed casting system according to preliminary dimensions has been proposed.

Publication activity

Three articles in English language scientific magazines based on the topic of the PhD thesis have been presented. They confirm the author's abilities to do exhaustive scientific analysis and to interpret correctly the achieved results.

Abstract

The abstract in terms of content, meets the requirements of the Regulations of MU – Varna and comprehensively reflects the aim, tasks, conclusions, contributions and obtained scientific results.


CONCLUSION

The PhD thesis: **CASTED METAL RESTORATIONS, CONSTRUCTED FROM 3D PRINTED PROTOTYPES USING LASER STEREOLITHOGRAPHIC PRINTER**” contains scientific and scientific-applied results, which represent an original contribution to science and meets all the requirements of the law of development of the academic staff in Republic of Bulgaria and the Regulations of MU – Varna.

The PhD thesis shows that **Dr. Preslav Plamenov Penchev** has exhausted theoretical knowledge and practical skills in the specialty of “Prosthetic Dental Medicine”, demonstrating qualities and abilities for self-training research and interpreting the achieved data.

As a result of all this, mentioned above, I confidently give **my positive assessment** of the research presented, by the above peer-reviewed dissertation and I invite the esteemed scientific jury to award the educational and scientific degree "Doctor" to **Dr. Preslav Plamenov Penchev** in a doctoral program Prosthetic dentistry, professional field 7.2. Dental medicine, Higher educational sphere 7. Healthcare and Sports.

16.01.2021



Assoc.-prof. Ilian Hristov, DMD, PhD
Department of Prosthetic Dentistry
FDM, Medical University - Plovdiv