O P I N I O N

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of **Assoc.Prof.Dr. Nikolay Svetoslavov Yanev, PhD**

for a dissertation on the topic "Algorithm for clinical application of virtual planning, modeling and 3D printing in local, regional and micro-vascular reconstructions of complex maxillofacial defects"

to acquire the scientific degree "Doctor of Sciences"

District 7. Health care and sports, Professional direction
7.1. Medicine, Scientific specialty "Neurosurgery"

The opinion is prepared on the basis of Order No. РД-26 1325/30.05.2022 of the Executive Director of UMHATEM "N. I. Pirogov", on the basis of Art. 32, par. 2 and 3 of the Regulations for the development of the academic staff at UMHATEM "N.I. Pirogov" EAD, Sofia, according to the decision of the Scientific Council with protocol No. НД-01-2/18.05.2022.
Assoc.prof. Yanev presents a dissertation, an abstract and all necessary documents in accordance with the Regulations for the Development of the Academic Staff at UMHATEM "N.I.Pirogov" - Sofia.

Biographical data

Assoc.Prof.Dr. Nikolay Svetoslavov Yanev, PhD, was born on July 5, 1976 in the city of Ruse.

In 2002, he received a master's degree in dentistry at the Faculty of Dental Medicine in Sofia with excellent results.

In 2010, he received a second master's degree in medicine, Faculty of Medicine, MU - Sofia, also with excellent results.

In 2011, he acquires a specialty in maxillofacial surgery, MU - Sofia and a PhD in medicine - MU, Sofia, for the successful defense of a dissertation on the topic: "Mechanism directed treatment of pain - experimental models and pharmacological effects", developed in the Department in pharmacology and toxicology at the Sofia University

In 2013, he acquires a specialty in oral and maxillofacial surgery in Great Britain (UK GMC Specialty registration – Oral and Maxillofacial Surgery)

In the period 2012-2018 he works in Great Britain as:

– 07.2012–04.2013 – Clinical Fellow, Head and Neck Department, University College London Hospital NHS Foundation Trust, UK

– 04.2013–07.2015 – Clinical Fellow and Honorary Clinical Fellow Maxillofacial Surgery, Head and Neck Department, Royal Derby Hospital, UK

– 08.2015–09.2019 – specialist maxillofacial surgeon, Specialized Hospital for Maxillofacial Surgery – Sofia (SBAL for LCH)

– 02.2016–03.2017– Locum Consultant Maxillofacial Surgeon, Head and Neck Department, Royal Derby Hospital, UK

– 12.2016–03.2018 – Associate professor at the Department of Pharmacology and Toxicology of the MU – Pleven

– 12.2016 – Associate professor, Medical University – Pleven

– 04.2017–04.2018 – Consultant Maxillofacial Surgeon, Head and Neck Department, Royal Derby Hospital, UK

In 2018 – acquires pan-European certification in the specialty of oral and maxillofacial surgery according to the requirements of the Board of Oral and Maxillofacial Surgery of the European Council of Medical Specialties (UEMS) and acquisition of the title – Fellow of the European Board of Oral and Maxillofacial Surgery (FEBOMFS)

– 04.2018–12.2019 – associate professor at the Research Institute of the MU – Pleven

- 09.2019 - Associate professor, UMHATEM "N.I. Pirogov" - Sofia

– 09.2019–05.2022 – Head of the MFS Unit, UMHATEM "N.I. Pirogov"

Membership in professional organizations

– 2010–2016 – representative for Bulgaria in the European Association for Craniomaxillofacial Surgery (European Association for

Craniomaxillofacial Surgery – EACMFS) and its full member (Active Member)

– 2010–2016 – representative for Bulgaria in the International Association for Oral and Maxillofacial Surgery (IAOMS) and its full member (Fellow)

– Currently a member of: British Association of Oral and Maxillofacial Surgery (BAOMS); The Society of Oral and Maxillofacial Surgeons in Bulgaria; The Bulgarian Medical Union; The Bulgarian Dental Union; General Medical Council (UK), with a specialty in oral and maxillofacial surgery recognized in Great Britain; Fellow of the European Board of Oral and Maxillofacial Surgery (FEBOMS); SORG Associate Member.

Characterization and evaluation of the dissertation work

The dissertation work of Assoc.Prof.Dr. Nikolay Yanev consists of 246 standard pages and is illustrated with 12 tables and 147 figures. It is structured correctly. Contains: used abbreviations, introduction, literature review, aim and objectives, own research, material and methods, results and discussion, conclusions, bibliography. The bibliography includes 253 literary sources, 15 in Cyrillic and the rest in Latin.

The literature review is highly informative, shows the current state of microvascular surgery and defines it as the most complex rung of the modern reconstructive ladder. The Bulgarian experience in microvascular and digital-assisted reconstructive facial surgery in Bulgaria was also shared retrospectively.

The aim of the dissertation work is clearly formulated - the creation of an algorithm for clinical application of the methods of virtual 3D planning, modeling and printing in local, regional and microvascular reconstructions of extensive bone defects in the maxillofacial region, after the implementation of the relevant surgical treatment and follow-up of its results.

The five tasks are specific, correctly defined and fully correspond to the set goal.

1. Systematization of the necessary preparatory studies and the steps in the process of virtual planning, modeling and corresponding bony maxillofacial surgical intervention.

2. Production of individual 3D jaw models for patients with bone resections and reconstructions and individualization of standard reconstructive implants based on them, as an initial stage of application of digital methods in surgical practice.

3. Complete process of digital planning, modeling, operative simulation, production of surgical transfer guides and 3D patient-specific implants.

4. Intraoperative application of the individualized standard implants according to the produced 3D jaw models, as well as the 3D printed patient-specific implants and surgical guides.

5. Summarizing an algorithm for applying the methods of virtual 3D planning, modeling and printing in local, regional and microvascular reconstructions of extensive bone defects in the maxillofacial region.

Conclusions

On Task 1

1. The precise computed tomography examination, specifically aimed at patients undergoing microvascular reconstructive surgery in the head and neck region, with a donor area in a remote part of the body, is fundamental to the implementation of the entire process of virtually planned and digitally assisted maxillofacial surgery.

2. The systematization of the approach for investigation and preparation of clinical cases including virtual planning and modeling are the basis of the created and fully developed national and international interdisciplinary medical-engineering cooperation.

3. The implementation of virtually planned operative interventions, including complex maxillofacial resections with one-stage microvascular reconstructions and with one-stage regional axial reconstructions, meets the contemporary international standards for interdisciplinary and advanced technology-based work.

On Task 2

1. In patient cases with bone resections and reconstructions, a fundamental stage of the application of digital methods in reconstructive surgical practice is the production of individual 3D jaw models and the individualization of standard reconstructive implants according to their shape.

2. Clinically verified in perioperative setting are three-dimensionally printed patient-specific cranio-maxillo-facial models depicting real bony anatomy (in 25% of cases in our series), reconstructed image of bony anatomy (in 33% of cases) and real bone pathology (in 42% of cases).

3. Patient-specific models support complex reconstructive bone surgeries by using them to individualize different types of standard fixation or contour implants: reconstructive plates (in 56% of cases in our series); miniplates (in 31% of cases) and orbital implants (in 13% of cases).

On Task 3

1. The comprehensive process of comprehensive digital-assisted surgery, which has recently been introduced into international clinical practice, including virtual planning, modeling, operative simulation, production of surgical resection and reconstructive transfer guides and patient-specific implants, is currently being regularly applied in Bulgaria as well, initially with international interdisciplinary expertise, having the potential to shape real national medical-engineering cooperation and development.

2. By means of the presented methodology, a wide variety of stabilization, fixation, contour and hybrid patient-specific implants could be constructed with significant benefits regarding the implementation of both the functional and aesthetic components of complex maxillofacial restorations.

3. The construction, in particular, of the resection and reconstructive surgical guides can be carried out according to the preferences of the surgeon himself and ensure predictable and stable work both with regard to the ablasticity and radicality of the resection part of the operation, and with regard to the delicate process of segmentation of the donor reconstructive bone structures regardless of the volume of the soft tissue component in composite microvascular flaps.

On Task 4

1. Multicomponent digital-assisted surgery has been successfully introduced into maxillofacial surgical practice both in combination with microvascular reconstructions (in 54% of cases in our series) and with regional axial reconstructions (in 46% of cases).

2. Verified as extremely precise and accessible to use is the part of the application of surgical guides both in the resection part of the operation and in the reconstructive stages, regardless of the number of segments in the bone flaps (between 1–4 segments in the different bone flaps in our series).

3. The laser-sintered patient-specific 3D implants manufactured according to the described protocol adapt intraoperatively exactly to the actual contour of the bone generated preoperatively from the CT images and demonstrate superiority over standard reconstructive plates individualized according to the 3D patient-specific models.

4. The derived 3D graphical statistical relationships support the application of both fully digitally produced patient-specific implants and individualized implants, together with regional axial reconstructions, which,

unlike microvascular reconstructions, are not bone-based, but entirely soft-tissue based.

On task 5

1. On the basis of the acquired scientific and personal surgical clinical experience, the aim of the present dissertation was fulfilled and an algorithm was created for the clinical application of the methods of virtual 3D planning, modeling and printing in local, regional and microvascular reconstructions of extensive bone defects in facial jaw area.

2. The algorithm is based on the follow-up and summarization of the results of the complex resection and reconstructive treatment of facial pathology. It systematizes the approaches for digitally-assisted surgery in cases of complex maxillofacial bone pathology with an impending or existing extensive defect - integrating the possibilities of both operative intervention only by the help of an orienting individual patient-specific maxillofacial and/or donor 3D model , or for a fully developed concept of virtual planning, modeling, resection and reconstructive simulation and 3D printing of surgical guides and patient-specific implants, combined with various options for tissue defect repair, incl. and with microvascular bone reconstruction.

3. The follow-up and analysis of the achieved clinical results provides the basis to recommend the formulated algorithm to be included in the postgraduate training programs in maxillofacial surgery, dental, oral and maxillofacial surgery, neurosurgery and plastic-reconstructive surgery, as well as applied in the clinical practice of the relevant specialists in Bulgaria.

I accept the significance of the dissertation work and the contributions made:

1. A specialized protocol has been created for computer-tomographic examination of patients undergoing microvascular reconstructive surgery in the head and neck area, with a donor area in a remote part of the body. It allows the generated image information to be directly exported to the planning server and simultaneously used for the purposes of digital planning methods.

2. The first series of fully virtual planned and 3D modeled microvascular reconstructions of extensive maxillofacial defects stabilized with laser sintered patient-specific implants was performed. This clinical project is based on international technological cooperation and Bulgaria's own surgical experience.

3. The application of both individualized standard implants and patient-specific implants with the two main reconstructive methods of complex maxillofacial defects – microvascular and regional axial flaps – has been verified.

4. A series of virtually planned resection and reconstructive surgical guides were applied for the first time in clinical practice in our country for the exact transfer of the virtual plan in each of the performed real operative interventions.

5. A series of innovative hybrid multisegmental mandibular patient-specific implants were virtually designed and clinically applied in fibular microvascular reconstructions, with an implant base restoring the contour of the jaw according to the individual characteristics of the patient and a stabilizing part of the implant allowing positioning of the fibular bone section in optimal alveolar mandibular position, with a view to correct intraoral restoration and dental prosthetics.

6. Two-piece Titan-REEK mandibular and craniofacial implants are virtually designed, manufactured with combined 3D technology and clinically applied.

7. Virtual planning and clinical application of navigated dental implants in previously virtually planned microvascular fibular reconstructions stabilized with 3D printed patient-specific implants was performed.

8. An algorithm was created for the clinical application of the methods of virtual 3D planning, modeling and printing in reconstructions in the maxillofacial region, which could be used on an interdisciplinary basis by all specialists working in this complex area of the human body.

In his dissertation work, Assoc.prof. Yanev presents an algorithm for clinical application of virtual planning, modeling and 3D printing in local, regional and microvascular reconstructions of complex maxillofacial defects, created on the basis of his own clinical experience.

Abstract

The abstract fully meets the requirements of LDASRB as the scientific research and its results are presented in a synthesized form.

On the topic of the dissertation, 15 publications in specialized scientific editions and 6 scientific forum participations are presented.

The dissertation fully meets all the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria and the Regulations of UMHATEM "N.I. Pirogov", Sofia, for its application.

In conclusion: I give a positive assessment of the dissertation work on the topic "Algorithm for clinical application of virtual planning, modeling and 3D printing in local, regional and microvascular reconstructions of complex maxillofacial defects". I am familiar with the professional route and

the development of Assoc.Prof. Nikolay Yanev as a responsible medic and a specialist with high contribution to the development of the microvascular surgery, the reconstructive and the maxillofacial surgery in Bulgaria. I will vote positive for **Assoc.Prof.Dr.Nikolay Yanev, PhD** to acquire the **scientific degree "doctor of science"** in the scientific specialty "Neurosurgery".

MD, to acquire the scientific degree "Doctor of Sciences" in the scientific specialty "Neurosurgery".

Sofia, 29 June 2022

Prof.Dr.Pavel Stanimirov, PhD