REVIEW

From **Prof. Dr. Nikolay Ivanov Dimitrov, MD.**

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Re: defense of the scientific work of **Dr. Petar Valentinov Petkov**,

on the topic of

"Post-traumatic stiffness in the elbow joint"

for acquiring the educational and scientific degree of "Doctor".

By order of the Rector of MU-Varna No. P-109-46/16.01.2026, I have been appointed as a member of the Scientific Jury and by decision of the latter (Protocol No. 1 from 28.01.26), I have been appointed to review the dissertation of **Dr. Petar Valentinov Petkov,** a regular doctoral student at the Department of Orthopedics and Traumatology of the Faculty of Medicine at MU-Varna, in the field of higher education 7. "Healthcare and Sports" in the professional field 7.1 "Medicine" and the doctoral program "Orthopedics and Traumatology."

The elbow joint, as is well known, has a complex anatomical configuration, which predisposes it to vulnerability in various clinical conditions, especially after different types of soft tissue trauma and even more so after disruption of the bone integrity of the joint structures. Most common injuries leading to complications could be luxations, recurrent luxations, multifragmentary fractures of the distal humerus, intra-articular fractures of the proximal part of the forearm, ligamentous lesions, subchondral lesions, the large group of prolonged, chronic microtrauma to the intra-articular structures of the joint, as well as the severe consequences of burns. Traumatic brain injuries with long resuscitation stays are the biggest indirect cause of these complications. This etiology leads to various post-traumatic conditions, the most common of which are post-traumatic stiffness — contractures of the elbow joint and accompanying heterotopic ossification in the area. Unfortunately, when we want to help and apply a different surgical approach to this pathology, the unwanted symptoms often worsen instead of being overcome, as proven by global studies. This is

precisely where serious research is needed – to try to answer the questions of when and how the orthopedic team should intervene, which surgical methods should be used (preferably the most modern ones), and when and how to continue the kinesitherapeutic approach in order to ensure the most effective treatment.

These questions are currently addressed in the scientific paper presented for defense by Dr. Petkov, which is a prospective longitudinal clinical study involving patients who meet strict indications.

The functional results of patients from two study groups with an equal number of participants (45 in each group) are analyzed. The first group - early start of mobilization – 14 days after the injury/surgical intervention, followed by physical therapy and rehabilitation, with results recorded at three time points (T1, T2, and T3 – after immobilization, on day 15, and on day 30 post-surgery). The second group - late start of mobilization – removal of immobilization on the 30th day after trauma/surgical intervention, followed by physical therapy and rehabilitation and recording of results at three time points (T1, T2, and T3).

The dissertation is presented in the usual structure for this type of work, in 125 standard pages, using 10 tables, 19 figures, and 7 graphs, all of which are numbered and titled in Bulgarian. The figures and graphs presented are of high quality and informative, corresponding in meaning to the accompanying text. The dissertation has six applications that are used in the development - **1**. Individual patient protocol -Therapeutic group No. 1/early start of mobilization/; Individual patient protocol - Therapeutic group No. 2/late start of mobilization/; **2**. Mayo Elbow Performance Index (MEPS) functional assessment scale; **3.** Visual Analog Scale (VAS) for pain; 4. Data protection notice; **5.** Informed consent form**; 6.** Information for the patients.

In the remainder of the dissertation, Dr. Petkov formulates the objective and the resulting five tasks, the study contingent, the clinical methodology of the study, the techniques used to analyze the patients, his own results, author's analysis, and conclusions. The bibliography covers 19 pages, presenting 172 titles, without using any in Cyrillic.

The literature review is sufficiently comprehensive, covering all aspects of the issue. It mainly presents contemporary publications, most of which are from the last 5 years. The sources cited are from authoritative scientific journals. The review is 50 pages long and represents 40% of the dissertation. It presents the following in sequence:

Bone anatomy and capsuloligamentous anatomy – the shape, structure, and insertion into adjacent anatomical structures are examined. The static stability of the elbow joint, the medial and lateral ligament complex, which represent the thickening of the capsule. Biomechanics of the elbow joint - higher requirements for specific daily functions are established. Knowledge of these features is important when planning surgical procedures.

Etiology and pathogenesis - The etiology of elbow stiffness is multifactorial, resulting from extrinsic, intrinsic and combination of both causes with pathogenesis associated with progressive damage to the intra-articular cartilage. Extrinsic causes of limited elbow mobility are often heterotopic ossification, capsular contracture, postoperative complications associated with improperly restored anatomy, impingement from osteosynthetic implants, infections, etc.

Diagnostic describes the classic scales for assessing functionality: Mayo Elbow Performance Score (MEPS); Disabilities of the Arm, Shoulder and Hand (DASH) score/Quick DASH; The Liverpool elbow score (LES), which are well known in Bulgarian orthopedic practice and have already been translated and registered, but are shown here in order to materialize the results.

Classification: There are several classifications and scales for assessing the severity of elbow stiffness based on the cause of PTES, anatomical location, involvement of bone and/or soft tissue structures, severity of clinical presentation, and functional ability to participate in daily and work activities: Morrey's anatomical classification; Kay's classification based on the structures affected after trauma to the elbow joint; Vidal's classification based on the limitation in range of motion; S.T.I.F. classification.

S.T.I.F. (Structural, Tissue, Intrinsic, Functional), based on the different types of changes.

Prevention – Here, one of the main guidelines of the dissertation becomes apparent – namely, what are the main methods of prevention before postoperative elbow stiffness occurs. Key measures to prevent the development of contracture are early initiation of controlled mobilization, limitation of inflammatory reactions, reduction of the risk of infectious complications and heterotopic ossification, as well as the correct choice of therapeutic approach, tailored to the patient's condition.

Treatment - Elbow stiffness is one of the most common complications after trauma in this area. The goal is to support the natural healing process by controlling pain and swelling,

preventing contractures, and preserving the possible range of motion. The three phases of tissue changes are described in detail: inflammatory phase, fibroblast phase, and remodeling phase. The thesis that conservative treatment should not be underestimated is emphasized — static immobilization, static progressive splinting, dynamic immobilization, physical factors and rehabilitation, electrotherapy, magnetotherapy, laser therapy, cryotherapy, one of the most basic techniques – kinesitherapy.

Surgical treatment - Arthroscopic arthrolysis of elbow stiffness has many advantages over open arthrolysis. As a minimally invasive technique, arthroscopy offers better visualization of the joint, lower risk of infection, faster postoperative recovery, etc. There are already many publications on this method of treatment in our orthopedic literature, including official extensive studies. However, the learning curve is long and uneven, and neurological complications could compromise the results if training is not carried out consistently.

Open arthrolysis of the elbow joint is unfortunately still the main surgical method for severe elbow stiffness lasting more than 6 months and unresponsive to physical therapy, usually due to trauma, arthritis, or other diseases.

Endoprosthetics – total endoprosthetics of the elbow joint (arthroplasty) is a surgical method for restoring function in cases of severe elbow damage where conservative treatment has been unsuccessful. It appears that not only the most popular but also the most effective endoprosthesis system to date is the connected, semi-constrained Coonrad-Morrey system, despite the many modernizations and innovations made by leading elbow surgeons and the industry.

Complications - As a rule, complications in the surgical treatment of post-traumatic elbow stiffness are neurological on the one hand, or less fatal - recurrence of stiffness.

The literature review is specific to the dissertation and is a critical synthesis of Dr. Petkov's extensive knowledge on the issue - The search for the optimal treatment method continues due to the high degree of incomplete recovery, probably due to inappropriate and untimely treatment. Short-term immobilization for no more than 14 days, followed by early mobilization and a combination of physical therapy and rehabilitation, has proven to be an appropriate treatment method.

The goal set for the doctoral student is formulated in ChapterII: "To make a comparative assessment of functional recovery according to the factor "start of movement" of

the elbow joint: on the 14th day (early start) and after the 30th day (late start), with already diagnosed PTHS."

In view of the set goal, **5 scientific tasks** are formulated. They are logically justified, derive from the set goal, and are realistically achievable.

Chapter III, comprising six pages, presents the clinical material and methods used. The study presents a comparative assessment between early and late mobilization in order to determine the extent to which the time factor determines the final recovery outcome of elbow function. Patients after acute trauma/surgical intervention were included and followed up for the period April 2024 – April 2025. The study was conducted at the Maychin Dom Hospital in Varna – Department of Orthopedics and Traumatology. Patients who meet the inclusion criteria are divided into two groups with an equal number of participants (45 in each group):

Group "1": Early onset of mobilization – 14 days after trauma/surgery, followed by physical therapy and rehabilitation, with results recorded at three time points (T1, T2, and T3).

Group "2": Late onset of mobilization – removal of immobilization on the 30th day after trauma/surgical intervention, followed by physical therapy and rehabilitation and recording of results at three time points (T1, T2, and T3).

Clinical examination, questionnaire method, and goniometry are described. At each visit, patients are assessed using the VAS for pain and the Mayo Elbow Performance Score (MEPS). MRI is described as an instrumental method.
Descriptive and analytical statistical methods were used. Parametric analyses such as t-test and Chi-squaretest, two-tailed. The data were processed and systematized in MS Office Excel 2019, and IBM SPSS Statisticsfor Windows, version 26.0, was used for statistical analysis.

The results of the study are accurately presented in **Chapter IV**. They are 12 pages long and are supported by highly informative tables and graphs.
Descriptive methods were used to present data on the lateralization and location of the injury, the age of the trauma, and previous treatment. The reported VAS pain score in T2 shows a retention of the reported pain scores in Group 1, which is due to the inclusion of active and passive movements; in the second group, the trend towards improvement of this symptom is less pronounced: 36 (80%) patients report no pain and 9 (20%) patients report mild pain.

Early mobilization shows better results and a statistically significant difference in almost all measured indicators (flexion, extension, pronation, supination, PS arch, FE arch). Only in the MEPS indicator is the difference not statistically significant. This suggests that early mobilization may be preferable for improving motor indicators, but at this point in the follow-up, there is no evidence of a major impact on overall functional recovery. A comparative analysis of functional outcomes and Mayo Elbow Performance Score (MEPS) data emphasizes that the therapeutic method of early kinesitherapy is effective and leads to rapid restoration of normal elbow joint function.

A section is dedicated to the graphical representation of complications arising from the treatment.

The next chapter, **Chapter V**, which is seven pages long, presents the discussion of the dissertation. Here, the author's own results are presented, compared and supported by literature data. This chapter is the most creative part of the entire scientific work. It convincingly demonstrates Dr. Petkov's expertise in the presented subject matter, but also his understanding of the shortcomings of his own study.

At the beginning, he discusses that mobilization, started on the second day after the injury, leads to significantly faster recovery and better functional results compared to classic three-week immobilization. This dissertation research confirms the trends described in the literature. Patients in therapeutic group "1," in whom mobilization began after the 14th day, achieved faster pain reduction, a more significant increase in range of motion, and better functional scores on the VAS and MEPS scales compared to patients in Group 2, in whom rehabilitation was started after the 30th day. The first group achieved a functional range of motion (30° extension, 130° flexion, pronation and supination $\geq 50°$), allowing them to perform daily activities independently, while in the second group the improvement was more limited and recovery was slower. A comparison of the literature data and the results of the study leads to the categorical conclusion that early initiation of rehabilitation after immobilization is a decisive factor for the successful treatment of post-traumatic elbow stiffness. Delaying therapy after the 30th day compromises the recovery potential and limits the possibility of achieving the functional arc, probably due to the development of soft tissue contractures and other complications.

The conclusions from the discussion are described in **Chapter VI**. The analysis reaches several conclusions with which I wholeheartedly agree. The most significant of these is the first. The results of the study clearly show that early initiation of rehabilitation (as early

as the 14th day) leads to faster and more complete functional recovery compared to late initiation of mobilization (after the 30th day). Second, the effects were measured using objective and established methods – the VAS and MEPS scales, as well as an assessment of the range of motion, which ensures the reliability and validity of the results. The author acknowledges that the study has limitations – the relatively small number of patients and the relatively short follow-up period – there is no data on the long-term effects of therapy (e.g., after 6 or 12 months), but this also has a positive effect on the doctoral student's future research studies.

Chapter VII presents the extracts. These can be classified as **confirmative contributions**:

1. A comparative assessment between early (14th day) and late (30th day) initiation of mobilization in patients with post-traumatic elbow stiffness shows that early initiation of rehabilitation leads to better and statistically significant recovery of joint function.

2. The results prove that patients from the group with early mobilization achieve a functional range of motion and higher MEPS scores compared to those mobilized later.

3. The effectiveness of the multidisciplinary approach, including a combination of physical factors and kinesitherapeutic techniques, is demonstrated in both groups monitored.

The conclusion presents a summary of the author's views on the issue. It discusses the importance of the methodology used and the need for early rehabilitation as a key factor for successful recovery. Mobilization, started in the first weeks after immobilization is removed, has clear advantages: it shortens the recovery period, reduces pain, and allows for a faster return to functional capacity of the joint. This proves that not only the timing of the start of therapy but also the complexity of the methods used are of decisive importance. Neglecting timely and targeted treatment can lead to chronicity of the condition, which further complicates the recovery process. It demonstrates better treatment outcomes in the group of patients with early mobilization compared to the group with delayed rehabilitation in terms of pain, functional outcome, and development of chondral damage.

Dr. Petkov has presented two publications on the dissertation topic (all of which meet the criteria for actual publications). They are presented in **Chapter VIII**. They have been published in peer-reviewed journals that meet the minimum requirements for Area 7. Healthcare and Sports, in accordance with the Regulations for the Implementation of the Law

on the Development of Academic Staff in the Republic of Bulgaria of 2018. They contain separate parts of the developed material.

The abstract of the dissertation presented to me is 55 pages long and has been formatted in accordance with the requirements of Protocol No. 8 of the RTPAHDHAPMUV.

However, I cannot refrain from expressing my opinion on an issue that could be interpreted as a criticism. As I mentioned above, the problem of elbow stiffness has been studied in our native orthopedic literature — a dissertation on a similar topic has been written and defended. In this sense, there is a lack of knowledge of Bulgarian research output and no publications, of which there have been many in recent years, on modern issues with a significant international impact factor, as they are missing from the bibliography, which also lacks articles in Cyrillic. This, of course, does not diminish the value of the dissertation or the completion of the tasks, which leads to the achievement of the main goal of the scientific research.

In conclusion, the dissertation submitted for review demonstrates the author's ability to formulate a scientific thesis, develop a methodology for its solution, select and process material, and draw statistically reliable conclusions on a topical and specific topic: "Post-traumatic stiffness in the elbow joint."

The dissertation fully meets the qualitative and quantitative criteria set out in the Requirements for a dissertation for the acquisition of an educational and scientific degree "Doctor" at MU-Varna. For this reason, and due to the fact that all of the clinical material presented was almost entirely performed by Dr. Petkov himself, including surgical treatment, I give a positive assessment of the thesis and call on the members of the Scientific Jury to award **Dr. Petar Valentinov Petkov** the educational and scientific degree of "DOCTOR" in the scientific specialty of "Orthopedics and Traumatology."

20.02.2026г.,
Sofia

Prof. Dr. Nikolay Dimitrov, MD.